Telephone call management in the cognitive operating room

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Introduction

Mobile phones increase the reachability of surgeons and health care providers, thus facilitating decisions making and improving patient care [1,2]. Accordingly, phones are regularly taken into the operating room (OR). On the other hand, any intraoperative interruption increases the workload and may lead to a negative influence on the outcome [3,4]. Incoming telephone calls are responsible for as much as 1/4 of all disturbing intraoperative events [5]. To avoid this type of interruption, strict interdiction of telephone calls could be a simple and effective means. However the majority of incoming calls is not time-critical and not important, the lack of reachability could be detrimental in some cases. Accordingly, a complete elimination of mobile phones out of the OR is not an option.

To solve this problem, a situational aware system could be helpful which is able to discriminate between “important” calls and those which can easily be postponed. This paper discusses if a cognitive OR system could be used for a situation-adapted preselection of incoming telephone calls for the members of the surgical team.

Materials and Methods

Cognitive OR

In our “cognitive OR”, a central control and steering system is established, which collects a wide range of incoming information in real time [6]. Through “intelligent” interpretation of these data, based upon highly grained patient and surgical workflow models, the system is always aware of the actual situation and even capable to predict forthcoming events including the time left to the end of the surgery. In addition, it even classifies the actual state of the surgery according to “normal”, “irregular” or “critical”. The system described here is a middle ware between the person on the telephone and the surgeon addressed.

Call routing

Incoming calls for the surgeon (in our case to a DECT phone) are not directly forwarded to his phone. Instead the calls are routed to a call handler (Fig. 1). The call handler is provided by an Asterisk based VOIP server. This VOIP server directly interacts with the cognitive OR to get information about the current status of the surgery including the remaining duration. In addition, the central database is informed about incoming calls and is therefore able to display these calls on a central information unit or create a list of missed calls after the operation is completed. The VOIP server is also able to distinguish between calls from within the hospital network and calls from outside.

Figure 1: Call routing model

Caller interaction module

The decision whether the surgeon should be encountered with the call or not depends upon three different aspects:

I) Significance of the request
II) Actual surgical situation
III) Time line

I) Significance of the request

Many calls are neither time critical nor really important, but, of course, the system will be unable to classify the urgency of the call. This has to be left to the caller. The system, however, provides the necessary information to enable the caller to weigh up whether it is justified to contact the surgeon immediately or not.

II) Actual surgical situation

The workload during a surgical operation varies. If it is a comparatively easy case and if everything is running smoothly, the surgeon should be more open to respond to a telephone call than under severe strain. The situational aware system is able to classify the workflow as either “normal” (green), “irregular” but not yet dangerous (yellow) or “critical” (red). Accordingly, answers A, B or C
are selected. The type of answer may vary in the course of the operation.

Accordingly, the caller will be informed as follows:

A) “Dr. NN is currently doing a surgery which will probably be finished in … minutes/hours. Nonetheless, you could be put through if required. In this case, please dial “2”.

The threshold is, thus, comparatively low to contact the surgeon right now.

The next step is to make the caller a bit more hesitating to get connected:

B) “Dr. NN is at the OR table at the moment. The surgery will last for another … minutes/hours. Please, do not disturb unnecessarily. However, if your matter is urgent and cannot wait, please dial “2”.

It is assumed that the caller rather refrains from being put through to the surgeon.

If the situation in the OR is really critical and any unnecessary distraction has to be avoided, the reply has to be very deliberate:

C) “Dr. NN is currently doing a surgery. A call can only be accepted in vital cases. Can your call wait for another … minutes/hours? Only if you are sure it cannot wait dial “2”.

In this case, only really urgent calls should be connected.

III) Time line – estimated duration of the surgery

At the beginning of an operation it has to be expected that the surgeon will not be directly available on the phone for a considerable period of time. Accordingly, a better access should be granted to the caller as compared to later phases of the operation. If not determined otherwise, the system should routinely start with answer “A”. After 2/3 of the estimated duration, the answer is automatically switched to “B”. In any case, the caller will be informed about the expected duration of the operation.

Thus, the telephone management does not decide upon whether a caller is connected or not but it just modulates the threshold to contact the surgeon during the operation or not. To find out whether this method is effective in reducing the number of incoming calls without depriving the caller of the ability to reach the surgeon in critical cases, a study was conducted.

Survey

A list of different scenarios was presented to different healthcare providers of a surgical unit comprehending three different groups of matters of minor (class III), major (class II) or vital (class I) importance. Each test person was summoned up to call the respective doctor and got either the answer A, B or C, each with 3 different time estimations (60, 30 or 15 min till the end of surgery). It was protocolled if he/she insisted about getting connected.

Class III scenarios:
1. A former patient visits the surgical floor and asks whether he could briefly see the doctor who had successfully done his surgery 3 weeks in order to express his thanks.
2. The administration calls and asks to transfer a message to the doctor which is not urgent but important.

Class II scenarios:
1. The relatives of a patient are just paying her a visit. Since the patient will be discharged within the next days, they would like to ask for the doctor to get information about the organization of the further care.
2. A patient waiting for her surgery which will take place in about 2 – 3 hours is very thirsty. It should be adequate to give her 500 or 1000 ml of saline

Class I scenarios
1. A patient with the signs of an acute secondary haemorrhage after a cholecystectomy
2. A patient with clear clinical signs of an acute pulmonary embolism

In addition, every test person was asked to judge upon the value of receiving the estimated time left till the end of the operation by using a modified Likert Scale (negligible=1 to very helpful=5). To test the overall acceptance of the system the same Likert Scale was used.

Results

A number of 46 different healthcare providers participated in the survey. The results show a clear correlation between the significance of the request and the number of calls passed through (Fig. 2). For a request of minor importance (class III) 99% of all test persons dispense with a connection of their call. Out of 414 calls only 4 calls were forwarded. For the scenario with a request of major importance (class II) 7% of all calls were forwarded to the surgeon (29 out of 414 calls), mostly in a normal OR situation. In case of a request of vital importance (class I) 78% of all test persons decided to be connect to the surgeon (324 out of 414 calls). The results of the Likert scale for the value of receiving the estimated time left till the end of the operation were 4.0 for a request of vital importance, 3.5 for major importance and 2.6 for minor importance. The remaining operation time only showed an influence to class I scenarios (Fig. 3). Most callers refrained from being put through for the case of 15 minutes remaining operation time (63%, 57 out of 90 blocked
The overall acceptance of the system was resulted in a value of 3.5.

**Figure 2:** Calls blocked/forwarded by importance of the request and OR situation

**Figure 3:** Calls blocked/forwarded in case of a vital request by OR situation and remaining time

**Discussion**

The result of the survey clearly shows the advantage of the telephone management system. Unnecessary calls (request of minor importance) can be blocked and the surgeon is not constantly interrupted during the surgery. On the other hand important calls are still forwarded into the OR. The definition of the three different thresholds in combination with the estimation of the time left till the end of the surgery deliver the caller a clear impression of the current situation in the OR. Not only the surgeon, but also the caller benefits from the system. The time estimation was considered very useful by the vast majority of the test persons. The estimation is an important hint for most callers to decide whether they want to be connect or not, especially in class I scenarios. The prognosis also avoids unnecessary further call attempts within the estimated time period.

**Conclusions**

In this paper we presented a concept for telephone call management within the OR. A survey under different healthcare providers showed a broad acceptance and the need for such a system. Telephone management in the OR has to potential to reduce unwanted interruption during surgeries as well as to reduce the workload of surgeons and nurses without blocking urgent or important calls. The next step is to adapt these findings and to evaluate the call management system under real surgical conditions.

**References**


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