

Do we need to see patients following joint replacements or could we just call them up? Analysis using the Analytical Hierarchy Process.

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Abstract:

The Analytical Hierarchy Process (AHP) is a structured, multi-criteria decision-making (MCDM) technique developed by Thomas L. Saaty to organize and analyze complex problems. Based on principles of mathematics and psychology, AHP operates by decomposing a problem into a hierarchical structure of objectives, criteria, and alternatives. The core of the method involves a pairwise comparison of elements, where decision-makers use subjective judgments—quantified using Saaty's Fundamental Scale of Absolute Numbers—to evaluate the relative dominance of each element with respect to the level above it in the hierarchy. A key strength of AHP is its ability to integrate both concrete data and human intuition, translating qualitative preferences into quantitative priorities. This process ultimately calculates numerical weights for each decision alternative, providing a clear rationale for selecting the option that best achieves the stated goal. AHP is widely applied across diverse fields such as business, industry, and healthcare to support structured group decision-making.

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Introduction:

Analytical hierarchy process (AHP) is a structured technique for organizing and analyzing complex problems. It is based on mathematics and psychology and developed by Thomas L Saaty in the 1970's¹. Its application is particular in group decision making and used in fields of business, industry, healthcare, etc².

AHP explores the best decision that suits the goal and understanding the problem rather than coming to a correct decision.

AHP helps by first breaking down the decision problem into a hierarchy of more easily comprehended sub-problem, each of which can be analysed independently. Once the hierarchy is built, the decision makers systematically evaluate its various elements by comparing them to one another; two at a time, with respect to their impact on an element above them in a hierarchy.

AHP is important with respect to the fact that not only concremented data is used but human judgments can be used in performing evaluations. The evaluations are given numerical values such as

the Fundamental Scales of Absolute Numbers as suggested by Thomas L Saaty³. Numerical priorities are calculated for each decision alternatives to work out the alternative ability to reach a goal.

This is pair-wise comparison; in this way AHP allows entry of information about preferences in an intuitive manner. It involves comparing elements in pairs: identifying the dominant one and determining the degree of dominance in the mid-point scale.

The direct rating method could also be used as a default for evaluating alternatives. Each criterion is given weights and then further compared with each criterion for degree of dominance of each criterion in the context of each alternative, enabling comparisons of the weights of the criteria for the alternatives.

The problem:

A tertiary hospital wanted to develop a new service in the orthopaedic department for patients who have had lower limb major joint replacements (hip and knee joint replacements). The usual protocol for follow up after an

operation was to see them back in clinic and then followed up serially at regular intervals.

The follow up requires the patient to travel to the hospital either by hospital transport or by private conveyance which would incur car parking charges. Once in the hospital, the patients are made aware of the waiting times in clinic which may be a source of patient dissatisfaction as on occasions, they could be waiting for hours before they get to see a doctor.

The clinic requires nurses and doctors to run it and adequate staffing is essential. Nurses and doctors would see each patient to check for recovery following surgery, answer patient questions and deliver further information regarding rehabilitation and future appointments. This, in theory, should help alleviate any doubts and fears in patient's mind regarding post-operative rehabilitation, much needed reassurance. Reduced staffing due to sickness or unavailability will lead to increased waiting times and reduced patient satisfaction.

Introduction of a new service in clinics will modify the follow up in a way that patients will not be seen routinely in clinic. Instead, a nurse will call the patients six weeks after the operation and ask them a series of questions and try to answer their questions and reassure them. This in theory should be cost effective. The patients could be interviewed from the comfort of their own home and without the need of travelling to the hospital either on private or hospital transport. This will significantly reduce out patient waiting times. The cost of a telephone call to trust would be negligible as opposed to scheduling medical staff for clinics.

The downside, however, is to dedicate a nurse to make the phone calls which may cost in terms of resources; which means that there would be one less staff in the clinic. The nurse needs to be experienced enough to answer the patients questions otherwise there is a risk that the patients may not be reassured or satisfied with the consultation and would need to be seen in clinic. The accuracy of information between the medical staff and the patient is paramount. The more precise the information delivered to the patients regarding their post operative rehabilitation, the more the patient would be satisfied. If wrong or inadequate information is being delivered, the patient may become confused and would demand a clinic appointment to see the nurse or the doctor. Therefore, the reliability of the new

service comes into question.

Given the problem, it would be beneficial to use the analytical hierarchy process, to help make a decision between the two alternatives; we will define certain criterion and evaluate these deriving weights (importance) using the pair-wise comparison and evaluate the alternative by direct rating.

The Software:

The software used Make It Rational⁴ is decision support software based on AHP. It allows to set alternatives and criteria and the weighting method of these can be evaluated using the pair wise comparison and the direct rating method. It used the scale for absolute numbers to check for dominance between each criterion. The results are summarized weights of each criterion as a pie-chart. The report can be downloaded as an HTML webpage, Microsoft word document and a PDF document. The basic software allows only two evaluators. The software is used by the MBA student for the purposes of this assignment and is the first evaluator. The 2nd evaluator is a layman to the specialty of orthopaedics but a clinician and understands the importance and relevance of each criterion. This would help reduce bias in the results. The software asked the two evaluators to compare criteria to determine the dominance of each criterion when compared with the others. The software also corrects for discrepancies in domination when doing pair wise comparison between criteria either with one or two evaluators and suggests weights for each criterion.

The Goal:

To improve efficiency of follow up in clinic after lower limb joint replacements.

The goal of the trust would be to minimize cost and maximize efficiency but on the other hand maintain top standards of patient care. The patients are discharged after their operation with advice on postoperative recovery and rehabilitation and the follow up visits are to review their progress, rule out early complications and reassure patients. The telephonic interview would seemingly help in minimizing cost of running a clinic but concerns regarding reliability of the service to deliver accurate information to the patients may be questionable.

The Alternatives:

Conventional follow up (CFU)

This would mean that the trust would continue to run clinics for follow up six weeks after lower limb joint replacements where patients would be seen physically by the nurses and doctors and further clinic appointments made thereafter.

Telephonic service (TS):

The alternative would be the introduction of a new service of telephonic interview of the patients six weeks after their surgery, when a series of questions regarding their health, recovery, complications and mobility will be asked and advice given accordingly. Future consultations would also take place via telephone unless concerns arose.

Explanation of the criteria:

Each of the criteria discussed would have some impact on either the patient or to the trust. The criteria are weighted on the basis of what is being evaluated. Both the pair-wise comparison (for deriving weights of the criteria) and direct rating in the context of improving efficiency in clinic following joint replacements (for evaluating alternatives) would be undertaken.

Cost of Telephone call:

The cost of making a call to the trust should be negligible as compared to running an entire clinic for patients. The cost incurred may not be monetary but non-monetary as there should be time spared by the nurse to make the call. The environment should also be made appropriate to make the call. The call should be made in an office away from the noise of a busy clinic; there should ideally be no traffic into and out of the office to avoid distraction and breach of confidentiality. The call made may not be able to confirm the identity of the receiver of the call or at times difficult to get the patient to the phone or is unavailable and would require repeated phone calls before the telephonic interview could take place.

Assessment of Patient remotely via telephone – comfort:

The patients may prefer to be called at home. Most of these patients are in older age group and for most of them some form of transport would need to be arranged. They may be dependant on hospital transport or their next of kin to take them to the hospital and back. It would be ideal for them to be interviewed by a nurse via telephone in the comfort of their own home.

Ease of nurse to call patient:

A nurse dedicated to call the patients could effectively interview a greater number of patients in a relatively short time period hence proving to be cost effective. It would also mean that this nurse needs to be taken out of her routine clinic work to call patients, which would reduce working staff on the clinic floor increasing pressure on the remainder nurses and doctors working in other clinics. This would consequently increase outpatient waiting times for other clinics which may be a cause of concern to the trust unless staffing levels are increased.

Cost of Nurse per Call:

There may be no monetary cost incurred when the nurse is making a call however job planning of nurses will involve rescheduling of duties to enable them to run such clinics and may need to increase their salary. She may, however, have to find time within her busy schedule to sit down and make call to a number of patients each week. If the experienced nurse making the call had called in sick, dependence on specialist nurses results in clinics suspended or postponed in sickness, absence or holidays unless alternate arrangements are made. This questions the reliability of the service.

Costs of transport arrangements:

Transport arrangements need to be made for some patients as they may not be able or have transport to get to and back from the hospital. This cost is usually met by the trust. With telephonic service, this cost could be virtually eliminated. On the other hand, the patients requiring transport are the ones with various other medical illnesses and co-morbidities and need paramedical staff to accompany them to clinic. Telephonic interviews may not be advisable for this group of patients, as in clinic the patients could be cared not only for joint replacements but a chance to optimize their health status.

Car parking charges:

When the patients come in for a clinic appointment, if they come by private conveyance they have to incur the cost of car parking in the hospital. This reduces patient satisfaction as they may sometimes have to wait long hours before seeing a health professional and may have to make further payments toward car parking. The alternative service of telephonic interview may appeal to many as it will be a free service for

patients.

Outpatient waiting times:

The longer the patient waits to see a health professional the lower the satisfaction becomes. If the clinic over-runs, there is a cost involved with regards to staffing more nurses and doctors and these professionals may end up working out of hours, which reduces morale and increases dissatisfaction amongst the team members. This problem could be solved with telephonic service.

Reliability of follow up:

Conventional follow up has proved to be reliable historically as patients are seen in clinic after surgery and both the patient and health care professionals are reassured of optimum recovery and if complications have arisen, they could be dealt with early.

This however does not mean that telephonic interviews may not be reliable. If the information delivered on the phone is accurate it may still be reliable and enough to reassure both the patient and healthcare professionals about postoperative recovery. Some patients and healthcare professionals may question the reliability of telephonic service. It is essential, for telephonic service to be reliable, to train staff accordingly.

Accuracy of information delivered to patient:

This is a matter of delivery of information by the nurses and the perception of the patient. It may be that even with conventional follow up, when the patient is physically present, due to poor communication skills; the information delivered is not accurate.

The patient may feel that clear instructions and accurate information has been delivered via telephone and enough to continue with postoperative rehabilitation.

Patient satisfaction:

Patient satisfaction is of paramount importance, but it is difficult to measure patient satisfaction in numerical values. However, with pair wise comparison with another criterion becomes easier to weight it individually. There may be high or low patient satisfaction with the criteria discussed above.

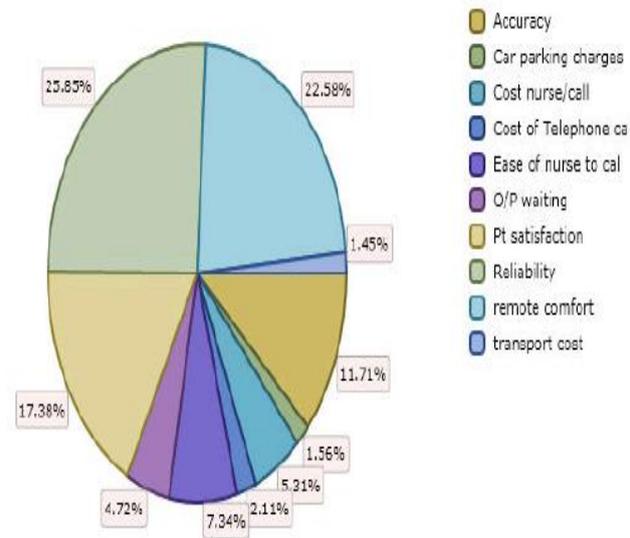
Results:

Both methods i.e. the pair-wise comparison and the direct rating method was used. Both methods were done with the intention to get an idea of which of the criteria comes out at the top in terms

of weightage. This will narrow down the few top criterion to help make a decision on which of the alternative is the best option.

Pair-wise comparison:

Using this method, reliability of follow-up is given the most weightage (Figure 1) at 25.85%, followed by remote assessment of patient via telephone (22.58%). Patient satisfaction (17.38%) and accuracy of information delivered (11.71%) had lower weights with pair-wise comparison. The rest of the criteria are presented in Figure 1 and Table 1.



Criterion	Weight
Cost nurse/call	5.31
Accuracy	11.71
Reliability	25.85
Car parking charges	1.56
Remote comfort	22.58
Transport cost	1.45
Pt satisfaction	17.38
Cost of telephone call	2.11
O/P waiting	4.72
Ease of nurse to call	7.34

Table 1- Weights assigned to individual criterion when using pair-wise comparison.

Direct rating method:

In the direct rating method, the software asks both the evaluators to assign weights to alternatives in context of each of the criterion (ie. ranked). Figure 2 shows a bar chart signifying the percentage utility of each of the criterion in the context of the two alternatives. There is increase pressure on clinics with conventional follow-up and there is high weightage in this group given to outpatient waiting times. Transport cost seems to be a feature of the conventional follow up. There is not much difference in reliability between the CFU and TS alternative services (51.52 and 48.48 respectively) as well as patient satisfaction (52.94 and 47.06 respectively) between the two as shown in Table 2.

Criterion	CFU	TS
Cost nurse/call	0	100
Accuracy	56.25	43.75
Reliability	51.52	48.48
Car parking charges	88.89	11.11
Remote comfort	60	40
Transport cost	100	0
Pt satisfaction	52.94	47.06
Cost of telephone call	0	100
O/P waiting	88.89	11.11
Ease of nurse to call	0	100

Table 2- Derivation of weights for alternatives compared to each criterion.

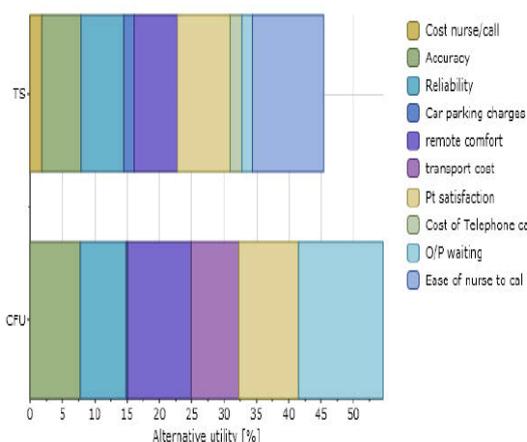


Figure 1 - Ranking of alternatives in the context of improving efficiency of follow-up in orthopaedic clinic.

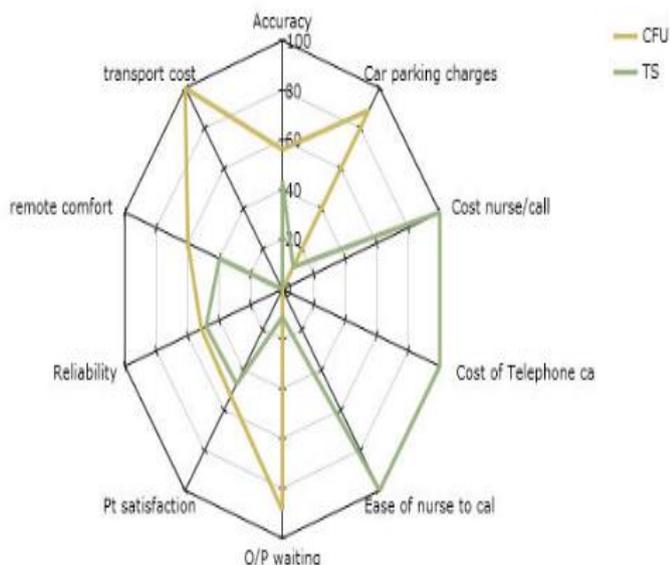


Figure 2 - Comparison in context of: Improve Efficiency of Orthopaedic Clinic Follow up.

The radar chart shown in Figure 3 reflects the community and the outliers amongst the alternative services. The conventional follow-up services slightly more accurate (56.25) in delivering information as compared to the telephonic service (43.75). It is high on transportation cost and car parking charges for the patients, average for comfort, reliability and patient satisfaction.

The telephonic service alternative has costs associated with it including employing a dedicated nurse, cost of the telephone call and in doing so it may not be as accurate in delivering information to the patients. It is however easier for the nurse to call the patients, incurs no transportation costs or waiting times.

It is worth noting from the radar chart the two important criteria reliability of both the services and the patient satisfaction share a common area on the chart and a similar in weights shown in Table 2.

Discussion:

AHP helps in decision making rather than making the decision. By breaking down the problem into a hierarchy, each of the criteria is looked into with great detail and both numerical and abstract importance could be assigned to the best combination that suits the goal. Once the initial results are known, the individual weights of each criterion could be changed to see if they would have significant impact on decision making or not. The goal of improving efficiency of follow up using either of the two alternatives, could be

achieved by analyzing each criterion with may have an impact on achieving the ultimate goal of maximization of efficiency. The software used Make It Rational is easy to use web based software that does not require additional training and user friendly ⁴. The basic package offers the facilities of two evaluators, but in actual practice, seven to eleven evaluators may be used for decision making process, either remotely or as a group to come to a decision. It allows each evaluator to assign numerical weight to each criterion according to the evaluator's perception of importance and relevance of the criterion and its impact on decision making.

The patients when seen through conventional follow up would need to come into hospital either at the cost to the patient or to the trust. They would inevitably be subjected to some amount of waiting in the clinics. They would however be seen by health care professionals in person, their questions about surgery answered and reassurance given with a degree of accuracy. Accuracy as noted, however, carries more weight in the CFU group (Figure 2) but marginally higher to the TS group (Figure 3) which is also reflected in the comparable results of patient satisfaction in the two alternatives (Table 2).

Telephonic service serves both the nurse and the patient in terms of ease of consultation remotely with negligible monetary cost. Reliability of the telephonic service has been questioned; however, the AHP software has been useful in analyzing both the alternatives with respect to this criterion and found comparable results for reliability of conventional follow up to telephonic service (51.52 and 48.48 respectively).

It is worth mentioning that with increased number of evaluators, the results may differ and also each criterion may have different importance to each evaluator. This will greatly help to come up with the best decision possible.

Conclusion:

The operational research modeling method used for this project (AHP) is a useful tool to plan services but the final decision should depict the intentions and values of the decision-making group and would help them to achieve a common goal and aid decision making when planning such services.

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