Interhospital transport of the critically ill patient
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Document Version
Publisher's PDF, also known as Version of record

Publication date:
2014

Link to publication in University of Groningen/UMCG research database

Citation for published version (APA):
Chapter 6
Regional impact of a Mobile Intensive Care Unit, 
an observational study

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Abstract

Introduction
In March 2009 we started a Mobile Intensive Care Unit (MICU) service, with a specially trained retrieval team. With a MICU, critically ill patients can be transferred more safely. An additional effect of a MICU might be an efficient use of regional ICU capacity. We performed a retrospective analysis to quantify this effect, taking into account the mortality after transfer and the costs.

Methods
We studied all MICU transports from March 2009 until September 2011. The reason for transport was determined and divided into three groups: Advanced therapy, Shortage of ICU beds or Send back. The level of the referral and receiving ICU was noted to classify the transports in an upward, downward or equivalent level of care. Mortality at 6 months was assessed. Costs and income over the year 2010 were calculated.

Results
Of all 353 transports, 229 were for advanced therapy of which 92% were transferred to a higher level ICU. 56 transports were due to shortage of ICU beds with an almost equivalent distribution to higher, lower and same level of ICU. 68 patients were send back of which 82% to a lower level ICU. Mortality at 6 months was 43%(advanced), 39%(shortage) and 26%(send back). Even without the costs for accompanying intensivists, costs are higher than income.

Conclusion
We have shown that regional ICU capacity can indeed be used effectively with a MICU. This might become more important in the near future because of an increasing demand and decreasing ICU bed capacity. From an economical point of view, a MICU with retrieval team is unprofitable in our region at the moment.
Introduction

Increasing awareness of patient safety revealed that in the chain of care for critically ill patients high-quality interhospital transportation is essential. Due to new regulations by the Dutch regulatory authorities in 2007 a nationwide system with seven Mobile Intensive Care Unit (MICU) centres was deployed[1]. After a period of preparation and training, in 2009 we started a Mobile Intensive Care Unit (MICU) service for the Northern part of the Netherlands. Until then, transporting the critically ill was performed with standard ambulances in most parts of the Netherlands and these transports have proven not to be safe enough[2, 3]. With a MICU and a specially trained retrieval team, sicker patients can be transferred more safely[4, 5]. This is the main advantage of a MICU. If transferring Intensive Care Unit (ICU) patients is safe, there might be additional benefits. The ICU capacity of a region could be used more efficiently. Sicker patients could be transferred more easily to a higher level ICU and recovering patients could be transported back to a lower level ICU. We performed a retrospective analysis to quantify this additional benefit.

Methods

We performed the transportations as described previously[4]. A specially developed and equipped ambulance with a custom made trolley was used. A driver, ICU nurse and intensivist, all specially trained, formed the crew. The system was available 7 days a week from 8.00 AM to 12.00 PM.

We analysed all MICU transports performed from March 2009 until September 2011 by our service. For every transport the reason for referral was recorded and divided into “advanced therapy”, “shortage of ICU beds” or “send back”. Sicker patients who were referred to a higher level ICU or patients needing specific treatment not available in the referral hospital were classified as “advanced therapy”. If the unavailability of ICU beds in the referral hospital was the reason for a transportation request, the transport was classified as “shortage of ICU beds”. If patients were stabilised and referred (back) to a hospital nearby their homes, they were placed in the “send back” group.

Furthermore, the ICU level of the referring hospital as well the level of the ICU of destination was noted to be able to classify every transport in upwards, downwards or equivalent level of care (from level I: small ICU up to level III: tertiary level ICU, classification according to the Dutch ICU guideline[6]).

Of all transported patients a “secondary” Acute Physiology and Chronic Health Evaluation (Apache) II score was measured. Instead of using parameters over the first 24 hours as in the official Apache II score, we used parameters on a single moment near the actual time of
transport. Statistics were performed using a one-way Anova test. Outcome data were collected from the hospital information system. Mortality was assessed 6 months after the transport date. For patients discharged from the hospital the national personal records database was checked for survival data (Table 1). Since this study concerns an evaluation of a present standard of care, ethical approval and informed consent are not a requirement. The medical ethics committee of our university medical center was informed and approved the design of our study.

<table>
<thead>
<tr>
<th>number of transports</th>
<th>Advanced</th>
<th>Shortage of ICU Beds</th>
<th>Send Back</th>
</tr>
</thead>
<tbody>
<tr>
<td>level up (%)</td>
<td>229</td>
<td>56</td>
<td>68</td>
</tr>
<tr>
<td>level down (%)</td>
<td>210 (92)</td>
<td>22 (39)</td>
<td>4 (6)</td>
</tr>
<tr>
<td>same level (%)</td>
<td>19 (8)</td>
<td>16 (27)</td>
<td>2 (3)</td>
</tr>
<tr>
<td>unknown</td>
<td></td>
<td>6 (9)</td>
<td></td>
</tr>
<tr>
<td>male (%)</td>
<td>115 (50)</td>
<td>32 (57)</td>
<td>39 (57)</td>
</tr>
<tr>
<td>mean age</td>
<td>51</td>
<td>66</td>
<td>58</td>
</tr>
<tr>
<td>“Apache II score”</td>
<td>13.2</td>
<td>16.1</td>
<td>11.2</td>
</tr>
<tr>
<td>mechanical ventilation (%)</td>
<td>186 (81)</td>
<td>48 (86)</td>
<td>36 (53)</td>
</tr>
<tr>
<td>number of patients on inotropes/vasopressors (%)</td>
<td>130 (57)</td>
<td>37 (66)</td>
<td>6 (9)</td>
</tr>
<tr>
<td>mortality at 6 months (%)</td>
<td>96 (43)</td>
<td>22 (39)</td>
<td>16 (26)</td>
</tr>
</tbody>
</table>

**Costs**

Our transport team is a combined effort of our hospital and the local ambulance service. Both the hospital and the ambulance service are paid separately. Costs are divided as well: costs for the vehicle and driver are accounted for by the ambulance service, costs for medical equipment, disposables, trolley, nurse and intensivist are accounted for by the hospital. These last costs were calculated and compared to the hospital credits for MICU transports during this period. Although we calculated the costs for nurse staffing we didn’t calculate the costs for intensivists. During our operational times (8 am - 12 pm) one nurse is uniquely available for the MICU. The nurse will perform tasks on the ICU during standby times as an extra help for his colleagues. The intensivist is solely available for the MICU as well, but will be able to work on other things like administration, protocols, research or education. Since it is very difficult to determine the costs for being on standby while performing “normal” duties, we did not take the costs for the intensivist into account.
Results

The region with roughly 1.500.000 inhabitants consisted of 12 hospitals with ICU beds: 8 hospitals with in total 39 ICU beds of Level I, 3 hospitals with in total 38 ICU beds of Level II and 1 hospital with 40 ICU beds of Level III. In the 30-months study period we conducted 353 transports. For all transports data were available for evaluation: 229 were conducted for advanced therapy of which 210 were transferred ‘upwards’ to a higher level ICU and 19 were transferred to an equivalent level ICU. Shortage of ICU beds was the reason for referral in 56 patients. Of these patients, 22 were sent to a higher level ICU, 18 were sent to a lower level ICU and 16 were sent to an equivalent level ICU. The remaining 68 patients were transferred (back) to a hospital nearby their hometowns. Of these 68 transported patients, 56 were transferred to a lower level ICU, 2 to an equivalent level ICU, 4 to a higher level ICU and 6 were transferred abroad (figure 1).

In the advanced therapy group complete “secondary” APACHE II score data were available for 191 (of 229) patients with a mean score of 13.2. In the “shortage of ICU beds” group, data were available for 45 (of 56) patients with a mean score of 16.1. In the “send back” group data were available for 51 (of 68) patients with a mean score of 11.2. APACHE II was not significantly different between the groups.

Figure 1. Percentage of transports to higher, lower or same level ICU for all groups
Outcome data
Of 342 out of 353 patients, survival at 6 months after transport could be assessed. Of the 229 patients transferred for advanced therapy 96 (43%) died within 6 months, 128 (57%) survived and 5 were lost to follow up. Of the 56 patients transferred for a shortage of ICU beds, 22 (39%) died, 34 (61%) survived at 6 months. Of the 68 patients transferred back, 16 (26%) died, 46 (74%) survived and 6 were lost to follow up.

Costs
The hospital’s financial department was asked to provide data on the costs of our MICU service over the year 2010. Costs for nurses, equipment and maintenance were calculated. Overhead costs were included as a fixed percentage of 35% within the specified items. This is a routine procedure within our financial department. Costs for disposables were estimated at 40 euro’s per transport. For each transport the hospital is paid a fixed price depending on the total duration (more or less than two hours). Costs and revenues over the year 2010 (127 transports) are presented in table 2.

<table>
<thead>
<tr>
<th>Debit</th>
<th>Amount €</th>
<th>Total €</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nurse staff expenses</td>
<td>376531</td>
<td></td>
</tr>
<tr>
<td>Equipment/maintenance</td>
<td>22469</td>
<td></td>
</tr>
<tr>
<td>Disposables (€40 per transport)</td>
<td>5080</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>404080</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Credit</th>
<th>Amount €</th>
<th>Total €</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Transport &lt; 2 hour</td>
<td>7512</td>
<td></td>
</tr>
<tr>
<td>124 Transport &gt; 2 hour</td>
<td>341276</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>348788</td>
</tr>
</tbody>
</table>

Overall result 2010* -55292

* Costs for accompanying intensivists are not included

Discussion
Our data show that two thirds of transports take place for medical rather than for logistic reasons. This well recognised reason for transport is still important despite the further evolution of the ICU in smaller hospitals with part-time intensivist coverage and renal replacement therapy. 24/7 intensivist coverage may be one of the reasons for transport, but probably the extra possibilities and skills in a larger hospital, for example radiological- or surgical interventions, extra corporeal circulatory and ventilatory support and organ transplant options are of greater importance. Although some of these interventions may diffuse to smaller hospitals, the past
has taught us that new therapies will continue to evolve necessitating transferral of patients to hospitals where this care is offered. In the Netherlands ICU levels range from I to III. Where level I implies a small ICU in a small hospital and a level III ICU is an ICU in a tertiary centre [6]. In the current guideline, intensivists on a level I ICU have to consult a colleague of a higher level ICU about every patient in their ICU who will remain there for at least three days. If treatment is too complicated or takes too long, this patient will be referred, increasing the burden of level II and level III ICU’s. This is in contrast with the situation in Northern America where other, less patient oriented reasons, play an important role as well in deciding where to transfer a patient to [7, 8].

Special medical care is going to be more and more centralised. For example, in the Netherlands surgeons are no longer allowed to perform complex procedures like oesophagus resections if they do not get enough exposure [9]. Agreements like these, advanced therapeutic possibilities and the rising age of the population put a growing demand on Level III ICU capacity. On the other hand, health care costs are exploding and the continuous shortage of especially ICU nurses makes it almost impossible to expand our ICU capacity. Therefore we are forced to use our present ICU capacity optimally. In the past Mobile Intensive Care Units and special retrieval teams have proven to be of value in transporting the critically ill safely [4, 10]. In this study we have shown the additional benefit of a MICU: transferring patients back to a lower level ICU. By referring patients back to a lower level ICU the increasing burden on higher level ICU’s will be relieved. Moreover, if regional ICUs can functionally act as one unit, ICU size advantage might lead to more efficient bed occupancy. With improving and becoming every day practice of patient transport we might get used to capacity indicated transport. In the near future we might get forced to use this option. It will become harder to maintain the present capacity for financial reasons and shortage of trained personnel, while demands are getting higher.

The Apache II scores used the way they are, are not validated because they are calculated on one time point and quite often after more than 24 hours of ICU therapy. Therefore they don’t reflect the severity of illness of the transferred patients and they cannot be compared to normal Apache II scores. Several scoring systems, including APACHE score have already been proven not to reflect prognosis for transferred patients, probably due to lead-time bias, which is the time already receiving medical care in the referring facility [11, 12]. In fact, no prognostic scoring system or severity of illness measure for this selected group of critically ill patients exists at this time.

Although there is not a significant difference between the groups, probably due to a number of incomplete data sets, it is quite interesting that the highest Apache scores were measured in the shortage of beds group and not in the advanced therapy group. This possibly reflects the instability of patients and not necessarily the severity of illness.
Both the “advanced therapy” and the “shortage of ICU beds” groups have a near 40% mortality at 6 months. Most reported mortality data are ICU and hospital mortality. Few studies are available for long term mortality after hospital discharge and even then, most of these studies are limited to certain age groups or subcategories of patients. Therefore, in hospital mortality ranges in different studies between 10 to 30%[13, 14] and 1-year mortality between 28 to 70%[15, 16]. Six-month mortality published by the Dutch ICU registry (NICE) is 22.9%[17], reflecting the total ICU population including the patients admitted after elective surgery. Mortality numbers for patients admitted to the ICU for medical reasons are almost 35% at 6-months[17]. Since our transported population consists of medical admissions, urgent surgery admissions or patients with complications, the 43% mortality at 6-months is in the expected range. Of course one could argue that transporting the critically ill could be a disadvantage and might result in higher mortality numbers. However, so far there are no data available to confirm this. Barratt et al. concluded that interhospital transfer resulted in a prolonged ICU stay, without an increase in mortality. However this study has been criticised[18, 19].

As has been shown, costs are high and in our region higher than the revenues. Since the majority of costs are staff expenses due to long standby time and revenues depend on actual transports, there will be a brake even point at approximately 250 transports. For our region this way of financing the MICU service is unprofitable, however since its value has been recognised this financial loss is accepted. If transportation options led to the use of spare capacity in the region the loss might be recovered quickly. However, the complicated health care financing system will make it difficult to return this gain to the actual investor.

Our study has its limitations. The study is relatively small and limited to one region. Comparison with historical data or data from others is not possible because the rapid changes in regional organisation as well as in medical technology. Lacking of a good scoring system prohibits benchmarking for transported patients. Lack of detailed insight in regional patient logistics e.g. bed occupancy, cancelled operations hampers conclusions about impact on efficiency. And costs are very difficult to calculate since they exist mainly on staff expenses. Work done during standby time is hard to calculate and the way personnel is deployed is of great influence as well, e.g. is personnel solely available of the MICU service or can personnel be drawn from the ICU. Costs of MICU services will therefore show great variations depending on how such a service is implemented within an intensive care unit.

In conclusion

With this study we have shown the regional impact of a mobile intensive care unit. The majority of transports is for medical reasons. The regional ICU capacity can be used efficiently without compromising patient safety. Moreover, to our knowledge, it is the first study reporting mortality numbers 6 months after transport.
References


