Impact of a multifunctional image-guided therapy suite on emergency multiple trauma care

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Background: The multifunctional image-guided therapy suite (MIGTS), a combined diagnostic and operating theatre, is currently the subject of considerable interest. This study investigated the effect of instituting a MIGTS on the emergency treatment of multiply injured patients.

Methods: This prospective controlled intervention study (MIGTS versus conventional treatment) included consecutive multiply injured trauma patients (Injury Severity Score of 16 or more) admitted between February 2003 and April 2005 to a university hospital. Main outcome measures were time to computed tomography (CT) and number of in-hospital transfers.

Results: A total of 168 patients were enrolled, 87 in the MIGTS and 81 in the control group. On average, CT was started at least 13 min sooner in the MIGTS group (P < 0.001), and these patients underwent fewer within-hospital transfers before arrival in the intensive care unit (median 2 versus 4 for controls; odds ratio –2.92, P < 0.001). Team members indicated increased satisfaction with the quality of the MIGTS procedure over the course of the study (P = 0.009). Thirty-day mortality rate (17 per cent for MIGTS versus 22 per cent for controls; P = 0.420) and long-term outcome did not differ between the two groups.

Conclusion: Implementation of a MIGTS in the emergency treatment of multiple trauma significantly accelerated the procedure and reduced the number of in-hospital transfers. Registration number: NCT0072213 (http://www.clinicaltrials.gov).

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Introduction

The speed and quality of diagnostic and therapeutic procedures are crucial in the emergency period of multiple trauma treatment in order to improve the outcome of patients and prevent unnecessary mortality. The newly developed multifunctional image-guided therapy suite (MIGTS) realizes the fundamental all-in-one concept for diagnosis and treatment. In the emergency setting, the MIGTS essentially combines standard high-quality imaging with an operating room, offering the possibility for complete diagnosis and treatment at one location until transfer of the patient to the intensive care unit (ICU). This approach avoids risky and time-consuming additional transports within the hospital, and allows rapid switches between diagnostic and sterile surgical procedures. The introduction of complex new technologies in an already stressful human-controlled environment, such as during the emergency period of multiple trauma management, may not only be costly but can also generate new risks. Up to now, sound data concerning such a ‘one-stop shop’ scenario for the emergency treatment of multiple trauma have been lacking. The difficulty of any quality control or study in the field originates from both the complexity of emergency procedures and the diversity of single cases and cohorts. Clinical monitoring, laboratory testing and outcome scoring can only partially assess the
appropriateness, effectiveness and efficiency of treatment. The demand for quality assessment in high-acuity surgery and the daily occurrence of critical incidences increasingly sensitizes the medical community to the challenges of integrating technologies.

This prospective controlled study assessed whether multiple trauma management can be safely optimized by the implementation of the new all-in-one concept of the MIGTS in comparison with the conventional standard procedure. The present pilot study was undertaken based on the hypothesis that a significant acceleration of the initial procedure until emergency computed tomography (CT) and a reduction in the number of in-hospital transports and transfers would be achievable with the MIGTS.

Methods

Setting

The MIGTS (Fig. 1) is positioned exactly between the emergency department and the operating theatres and consists of an oversized operating room (8.5 × 12 m) with a laminar air flow, a multidetector CT scanner (SOMATOM® Sensation 10; Siemens Medical Systems, Erlangen, Germany), an angiography system (Integris 3000; Philips, Eindhoven, The Netherlands), an adjustable imaging-compatible operating table on a ‘track’ system (Advanced Workplace for Image Guided Surgery (AWIGS); Maquet, Rastatt, Germany) and the availability of mobile diagnostic equipment such as for ultrasonography. The special radiolucent table is a...
Trauma patients in ED \( n = 353 \)

- MIGTS available
  - Yes \( n = 159 \)
  - No \( n = 194 \)

- Died in ED \( n = 0 \)
  - Died between ED and ICU \( n = 5 \)
  - Left MIGT for technical reasons \( n = 4 \)
  - Analysis (intention to treat) \( n = 87 \)

- Control group \( n = 81 \)
  - Died in ED \( n = 4 \)
  - Died between ED and ICU \( n = 4 \)
  - Left CT for technical reasons \( n = 1 \)
  - Analysis (intention to treat) \( n = 81 \)

Fig. 2 Inclusion of patients in the two groups. ED, emergency department; MIGTS, multifunctional image-guided therapy suite; ISS, Injury Severity Score; ICU, intensive care unit; CT, computed tomography

Combined operating room, CT and angiography table. Additionally, a life support trolley can be docked to this combined operating–imaging table, and the carbon-fibre tabletop (‘carrier’) can be moved with the patient on it, without the need for further patient transfers from one board or table to another. In this way, even when multiple diagnostic and therapeutic procedures are required, the MIGTS setting enables typical transfer–transport–transfer sequences to be reduced to two: the initial patient transfer from ambulance or helicopter to the transport carrier, and transfer to the ICU at the end of treatment.

**Treatment procedure**

All consecutive patients with the suspicion of major trauma treated between February 2003 and April 2005 at the authors’ university trauma centre were eligible for participation. They were evaluated prospectively by means of a standard comparative protocol approved by the local ethics committee. Patients were divided into two treatment groups (MIGTS and control) (Fig. 2), based on the emergency availability of the MIGTS unit, which was also used for diagnosis and image-guided procedures in other patients. After initial treatment in the emergency room (ER), multiply injured patients were transferred to the MIGTS if the room was available (MIGTS group; Fig. 3a). The available equipment enabled almost all diagnostic and therapeutic options to be performed in the MIGTS, including minimally invasive interventions and open surgical procedures for all disciplines. If the MIGTS was not available, multiple trauma patients followed the traditional pathway\(^{10}\), including transportation to the radiology department for further diagnostic tests (CT and angiography one floor below, and conventional radiology on the same floor) and/or to the operating theatre (control group; Fig. 3b). Patients who survived this initial period were then transferred to the ICU.

Interdisciplinary multiple trauma management followed the Advanced Trauma Life Support® treatment algorithms, and every trauma team leader (trauma-experienced and board-certified senior general surgeons) had passed the relevant course\(^{11}\). No additional hospital staff were required for clinical treatment in the MIGTS. Independent from the study group, emergency procedures were handled with identical in-house stand-by teams from all specialties, including a minimum of one resident and one general/trauma surgeon (team leader), one anaesthetist and one nurse anaesthetist, two or three emergency nurses, two radiology technicians, as well as one neurosurgeon in the case of neurotrauma. All other specialists were called as needed. Each patient initially arrived in the ER for primary
The ER was about 50 m from the ambulance gateway, as well as from the MIGTS, and from the elevator for patients transported by rescue helicopters. The ER could routinely accommodate two critically ill emergency patients at the same time, and had facilities for portable plain radiography and ultrasonography.

Patients were included in the final analysis if at least two Abbreviated Injury Scale (AIS) regions were involved, and the Injury Severity Score (ISS) as determined by specially trained staff surgeons at the end of hospital stay was 16 or above\(^{12,13}\). Patients with monotrauma, ISS below 16 or previous treatment in another hospital were excluded (Fig. 2).

**Outcome parameters**

For this pilot evaluation, the primary outcome parameters were defined as: the time interval between arrival of the patient in hospital and first CT, and the number of transports (from one room to another) and transfers (number of single movements of the patient between tables, boards or beds) between arrival of the patient in the hospital and first transfer to the ICU, or until death. In addition, overall staff satisfaction with single observed procedures was evaluated for the total study period using a Likert scale evaluation ranging from 1 (worst) to 5 (best)\(^{14}\), and collecting comments from the collaborators (physicians, nurses and technicians) of all disciplines involved. Medical
students specifically trained and on-call for the study documented the clinical procedures and the data for every case in a standard fashion.

Prehospital variables were extracted from the ambulance or helicopter documentation, and for further analysis first available prehospital or in-hospital values were used. Possible confounding variables, such as the time of day the patient arrived in the hospital (‘day-time’ 07:00–19:00 hours versus ‘night-time’), were tested. Descriptive variables, scoring systems and outcome parameters were used for comparison of data and subsequent evaluations. Objective and subjective patient outcome evaluations (length of stay; 24-h, hospital and 30-day mortality; and predicted Trauma and Injury Severity Score (TRISS) mortality\(^15\)), as well as a basic business-oriented cost description, were undertaken during the initial hospital period. Long-term outcome was assessed by determining 2-year mortality as well as Short Form 36 (SF-36\(^16\); Medical Outcomes Trust, Waltham, Massachusetts, USA)\(^16\) and Functional Independence Measure (FIM)\(^17\) scores.

**Statistical analysis**

Although not designed as a randomized investigation, power analysis was performed for this prospective controlled intervention study in order to estimate how many patients would be needed to demonstrate significant differences between treatment groups. Based on the primary outcome parameter, ‘time between arrival of the patient in hospital and first CT’, and using a previous retrospective investigation from the years 1997–1999 (mean(s.d.) 46(33) min; 50 patients per year)\(^18\), a time saving of 15 min in the MIGTS group seemed possible from a clinical point of view and was tested accordingly ($P < 0.050$, 80 per cent power, group size of 77 patients).

Owing to the limited number of patients, significant differences regarding objective and subjective outcome parameters, such as mortality or quality of life and subsequent health-related economic evaluation\(^19\), were not expected in this feasibility study. The respective parameters were recorded to acquire benchmarking data for future studies and for any comparison with the literature.

Data were analysed using SPSS\(^\circledR\) for Windows\(^\circledR\) version 13.0 (SPSS, Chicago, Illinois, USA). Mean(s.d.) and median values are shown for linear variables, and numbers with percentages for nominal variables. Analyses were performed on an intention-to-treat basis. Univariable linear regression was used to test differences between the groups, and $\beta$ values, which also represent the difference between group means, with 95 per cent confidence intervals (c.i.) are presented. All nominal data were retested with $\chi^2$ tests. These values are not shown as only minimal differences were found. $P < 0.050$ was considered significant for all analyses.

### Results

A total of 353 patients were treated during the study period. Some 185 patients were excluded as they had monotrauma or an ISS below 16. This left 168 patients, 87 of whom were enrolled in the MIGTS group and the remaining 81 in the control group (Fig. 2). Both treatment groups were comparable with regard to patient and trauma characteristics, except for more severe thoracic lesions (AIS 3) in the MIGTS group (Table 1). The number and type of diagnostic investigations and interventions applied during the emergency treatment period did not differ significantly between the two groups, apart from a higher rate of pelvic radiography in the MIGTS group (69 (79 per cent) versus 47 (58 per cent) in controls; $P = 0.002$). In the MIGTS

### Table 1 Comparison of main patient characteristics by means of linear regression analysis

<table>
<thead>
<tr>
<th></th>
<th>All patients ($n = 168$)</th>
<th>MIGTS ($n = 87$)</th>
<th>Control ($n = 81$)</th>
<th>$\beta$</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)*</td>
<td>42 (21)</td>
<td>43 (22)</td>
<td>41 (19)</td>
<td>1.88 (-4.45, 8.20)</td>
<td>0.559</td>
</tr>
<tr>
<td>Female sex†</td>
<td>44 (26.2)</td>
<td>24 (28)</td>
<td>20 (25)</td>
<td>0.03 (-0.11, 0.16)</td>
<td>0.672</td>
</tr>
<tr>
<td>ISS*</td>
<td>30 (12)</td>
<td>30 (11)</td>
<td>30 (13)</td>
<td>-0.18 (-3.87, 3.52)</td>
<td>0.924</td>
</tr>
<tr>
<td>AIS score‡</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>3 (2, 4)</td>
<td>3 (2, 4)</td>
<td>3 (2, 4)</td>
<td>0.19 (-0.33, 0.71)</td>
<td>0.473</td>
</tr>
<tr>
<td>2</td>
<td>0 (0, 2)</td>
<td>1 (0, 2)</td>
<td>0 (0, 1)</td>
<td>0.19 (-0.11, 0.50)</td>
<td>0.212</td>
</tr>
<tr>
<td>3</td>
<td>3 (2, 4)</td>
<td>3 (2, 4)</td>
<td>3 (0, 4)</td>
<td>0.59 (0.13, 1.05)</td>
<td>0.012</td>
</tr>
<tr>
<td>4</td>
<td>0 (0, 2)</td>
<td>0 (0, 2)</td>
<td>0 (0, 2)</td>
<td>-0.27 (-0.69, 0.15)</td>
<td>0.204</td>
</tr>
<tr>
<td>5</td>
<td>2 (0, 3)</td>
<td>2 (0, 3)</td>
<td>2 (0, 3)</td>
<td>-0.36 (-0.79, 0.06)</td>
<td>0.094</td>
</tr>
<tr>
<td>6</td>
<td>0 (0, 1)</td>
<td>0 (0, 1)</td>
<td>0 (0, 1)</td>
<td>0.16 (-0.02, 0.33)</td>
<td>0.075</td>
</tr>
</tbody>
</table>

*Values are mean(s.d.); values in parentheses are †percentages, ‡25th and 75th percentiles and §95 per cent confidence intervals. MIGTS, multifunctional image-guided therapy suite; ISS, Injury Severity Score; AIS, Abbreviated Injury Scale (1, head and neck; 2, face; 3, chest; 4, abdominal or pelvic contents; 5, extremities or pelvic girdle; 6, external lesions).
group, subsequent CT was commenced, on average, more than 13 min earlier than in control patients ($P < 0.001$) (Table 2). Patients in the MIGTS group experienced significantly fewer transfers between arrival in the hospital and first transport to the ICU compared with controls (median 2 versus 4 respectively; $\beta = -2.92$ (95 per cent c.i. −3.37 to −2.47), $P < 0.001$), who were transferred up to a maximum of 13 times. Overall, 50 patients (57 per cent) in the MIGTS group were transferred directly to the ICU with no additional transfer for a diagnostic or therapeutic procedure, compared with only 15 patients (19 per cent) in the control group ($P < 0.001$). The treatment procedure tended to be quicker up to the first operation in the MIGTS group compared with controls. For subsequent time periods, differences between groups were negligible (Table 2).

The 30-day mortality rate tended to be lower in the MIGTS group. However, as expected based on the power calculation, this and other possible differences concerning the clinical or subjective outcome (for example, mortality or quality-of-life evaluation with the SF-36$^*$/$\text{FIM}$ 2 years after injury) did not reach statistical significance (Table 3). Basic economic evaluation revealed similarity for mean(s.d.) costs charged by the hospital for patients in the MIGTS (€23 496(35 169)) versus controls (€24 317(29 240)) ($\beta = -1820$ (95 per cent c.i. −12 712 to 9071); $P = 0.870$).

Some 536 involved collaborators evaluated 120 multiple trauma situations (mean number per situation 4.5 (range 1–12)). Multiple trauma situations with staff evaluation did not differ significantly from those without feedback regarding main patient and process descriptions. The overall satisfaction (Likert 1–5) of care providers with the perceived quality of multiple trauma management was high, independent of the study group (mean(s.d.) 4.12(0.48) for MIGTS versus 4.08(0.37) for controls ($\beta = 0.04$ (95 per cent c.i. −0.11 to 0.19); $P = 0.610$). Over the course of the study, the overall satisfaction of co-workers in the MIGTS group improved significantly ($\beta = 0.003$ (95 per cent c.i. 0.009 to 0.006); $P = 0.009$) in contrast to the control group ($\beta = 0.001$ (95 per cent c.i. −0.002 to 0.003); $P = 0.651$). Involved collaborators’ comments chiefly concerned general aspects of the multiple trauma procedure independent of the study group, such as time management, team leader function or quality of staff training. Concerning the MIGTS, specific critical incidence experiences with machine malfunction or technical handling problems were criticized and the

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**Table 2** Comparison of procedural time intervals by means of linear regression analysis

<table>
<thead>
<tr>
<th></th>
<th>All patients (n = 168)</th>
<th>MIGTS (n = 87)</th>
<th>Control (n = 81)</th>
<th>$\beta$†</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prehospital period (min)</td>
<td>71(43), 60</td>
<td>68(26), 61</td>
<td>75(55), 60</td>
<td>−6.74 (−20.06, 6.57)</td>
<td>0.319</td>
</tr>
<tr>
<td>Arrival at hospital at night (19:00–07:00 hours)*</td>
<td>66 (39 3)</td>
<td>37 (43)</td>
<td>29 (36)</td>
<td>0.07 (−0.08, 0.22)</td>
<td>0.537</td>
</tr>
<tr>
<td>ER stay (min)</td>
<td>34(13), 33</td>
<td>34(11), 33</td>
<td>34(15), 33</td>
<td>0.15 (−4.01, 4.32)</td>
<td>0.942</td>
</tr>
<tr>
<td>Time to MSCT (min)</td>
<td>41(17), 38</td>
<td>35(11), 35</td>
<td>48(20), 45</td>
<td>−12.79 (−17.98, −7.59)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Time to first operation (min)</td>
<td>170(168), 125</td>
<td>155(157), 119</td>
<td>187(180), 142</td>
<td>−31.21 (−97.10, 34.69)</td>
<td>0.350</td>
</tr>
<tr>
<td>Interval between leaving ER and arrival in ICU (min)</td>
<td>257(172), 240</td>
<td>258(165), 241</td>
<td>256(181), 223</td>
<td>1.50 (−57.73, 60.73)</td>
<td>0.960</td>
</tr>
<tr>
<td>ICU stay (days)</td>
<td>7(10), 3</td>
<td>7(13), 4</td>
<td>6(7), 3</td>
<td>1.65 (−1.50, 4.81)</td>
<td>0.302</td>
</tr>
<tr>
<td>Hospital stay (days)</td>
<td>13(13), 11</td>
<td>14(14), 13</td>
<td>13(12), 9</td>
<td>0.55 (−3.43, 4.54)</td>
<td>0.785</td>
</tr>
</tbody>
</table>

Values are mean(s.d.), median unless indicated otherwise; values in parentheses are *percentages and 95 per cent confidence intervals. MIGTS, multifunctional image-guided therapy suite; ER, emergency room; MSCT, multislice computed tomography; ICU, intensive care unit.

**Table 3** Comparison of patient outcome by means of linear regression analysis

<table>
<thead>
<tr>
<th></th>
<th>All patients (n = 168)</th>
<th>MIGTS (n = 87)</th>
<th>Control (n = 81)</th>
<th>$\beta$†</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-h mortality*</td>
<td>13 (7.7)</td>
<td>8 (9)</td>
<td>5 (6)</td>
<td>0.03 (−0.05, 0.11)</td>
<td>0.467</td>
</tr>
<tr>
<td>30-day mortality*</td>
<td>33 (19.6)</td>
<td>15 (17)</td>
<td>18 (22)</td>
<td>−0.05 (−0.17, 0.07)</td>
<td>0.420</td>
</tr>
<tr>
<td>2-year mortality*</td>
<td>36 (21.4)</td>
<td>16 (18)</td>
<td>20 (25)</td>
<td>−0.06 (−0.19, 0.06)</td>
<td>0.323</td>
</tr>
<tr>
<td>Predicted TRISS mortality</td>
<td>0.21(0.28)</td>
<td>0.20(0.27)</td>
<td>0.22(0.29)</td>
<td>−0.02 (−0.10, 0.07)</td>
<td>0.696</td>
</tr>
<tr>
<td>2-year FIM</td>
<td>112(23)</td>
<td>113(23)</td>
<td>111(24)</td>
<td>1.65 (−8.07, 11.36)</td>
<td>0.737</td>
</tr>
<tr>
<td>2-year SF-36$^*$, mental</td>
<td>44(14)</td>
<td>44(14)</td>
<td>44(14)</td>
<td>−1.77 (−6.27, 2.73)</td>
<td>0.436</td>
</tr>
<tr>
<td>2-year SF-36$^*$, physical</td>
<td>46(11)</td>
<td>45(11)</td>
<td>47(10)</td>
<td>−0.55 (−6.52, 5.42)</td>
<td>0.856</td>
</tr>
</tbody>
</table>

Values are mean(s.d.) unless indicated otherwise; values in parentheses are *percentages and 95 per cent confidence intervals. MIGTS, multifunctional image-guided therapy suite; TRISS, Trauma and Injury Severity Score; FIM, Functional Independence Measurement; SF-36$^*$, 36-item Short Form health survey.
which included CT5 stop shop’ approach for diagnosis and treatment in the ER, given in the literature. Two groups published on a ‘one- registration of time flow or patient transfers, are rarely towards trauma patient management20. In the majority of was planned without considering an integrated approach clinically relevant complications for the patients concerned. to another CT or conventional X-ray room; there were no technical problems. These patients had to be transported be resolved before arrival of the patient. In four of 87 patients treated in the MIGTS and in one of 81 control patients, the procedure had to be interrupted owing to technical problems. These patients had to be transported to another CT or conventional X-ray room; there were no clinically relevant complications for the patients concerned.

Discussion

In this study, conducted at the University Hospital Basel, the novel multiple trauma MIGTS concept significantly accelerated the emergency process of multiple trauma management compared with a conventional strategy. In addition, patients in the MIGTS group had fewer within-hospital transfers before arrival in the ICU. These findings are likely to contribute to an improvement in the clinical outcome of severely injured patients if the potential of the MIGTS is fulfilled completely.

Until recently, the construction of most hospitals was planned without considering an integrated approach towards trauma patient management20. In the majority of centres worldwide, the ER, radiological and interventional facilities, and the operating theatres or ICU unit are located on different floors in different parts of the hospital. As a consequence, repeated patient transfers within the hospital remain inevitable3,121. Other newer emergency departments dedicated to the treatment of trauma have incorporated a digital X-ray scanner, CT or operating room in the ER or emergency department. None of these solutions meets the requirements of all diagnostic and therapeutic procedures being available in one room10,22–24. An analysis of preventable deaths in a high-volume level I trauma centre revealed important delays in taking patients to the operating room or in organizing transport25. This structural deficiency has resulted in the realization of the MIGTS5.

Comparative process data, including standardized registration of time flow or patient transfers, are rarely given in the literature. Two groups published on a ‘one-stop shop’ approach for diagnosis and treatment in the ER, which included CT5,26. Both evaluations were designed as pre- and post-interventions, each comparing a prospective and a retrospective trauma cohort. Moreover, results were limited because of missing data on clinical outcome5 and differently recorded time periods26. On average, a 13-min faster complete diagnostic workup was achieved for patients treated according to the new workflow concept26.

The integration of the MIGTS significantly accelerated the emergency treatment of multiply injured patients, as patients in the MIGTS group had CT 13 min earlier than controls. This may not seem clinically relevant as the ‘average’ emergency patient stable enough for CT is likely to tolerate a 13-min delay with no difference in outcome. In addition, the time gained by the MIGTS group was no longer significant for subsequent clinically relevant steps (first emergency operation, arrival in the ICU). This may be a statistical problem for a mid-volume single centre with a limited number of patients in an emergency setting typically demonstrating large standard deviations for many variables. Because of this anticipated obstacle, only initial time periods were formalized by the study. Equally, the maximum benefit of any gain of time will be expected for so-called ‘borderline patients’ who are apparently stable, or for unstable patients for whom further rapid diagnostic tests and immediate therapy in one room could be life saving and reduce further morbidity or errors in diagnosis25,27. In particular, such patients should profit from this accelerated and potentially more effective procedure.

As in elective surgery, minimally invasive procedures are being used for an increasing number of emergency procedures, including those indicated following major trauma11,28,29. The MIGTS infrastructure provides additional security for these patients by offering the possibility of performing diagnostic investigations to help control the patient or change the intervention at any time during the procedure4.

In the MIGTS, the number of transfers and transports of patients was significantly reduced compared with the control group. Consequent to this reduction, a reduction in unexpected and potentially harmful events, known to be highly associated with any transport of critically ill patients, can be assumed3. The actual number of critical incidents for transfers was not evaluated in the present study, but, as patients in the control group had, on average, two more transfers than those in the MIGTS group, the risk reduction can easily be estimated. Even when the (much lower) rate of technical malfunction occurring in the MIGTS (less than 5 per cent for all procedures) is taken into account, this is by far outweighed by the reduction in risk. In addition, this observed event rate showed a tendency to decline over the time in the MIGTS and should improve further with increasing experience. Nonetheless, the vulnerability of such a high technological scenario remains one of the concerns that led to the conception of this clinical study.
Another concern was the possible attitude of involved staff members towards the procedure. In the healthcare setting, the importance of human factors has been realized very late, although conflicts continue to increase with the implementation of new techniques. The main determinants of satisfaction continue to be discussed, and validated instruments for perceived quality of care are lacking. Most criticisms of the collaborators in the present study related to episodes of malfunction of the MIGTS, that is, typical problems concerning human–machine and machine–machine interfaces experienced during the introductory period of an innovation. Over the course of this study, the initially more sceptical attitude of staff members towards the treatment of multiply injured patients in the MIGTS became increasingly positive. The overall satisfaction with the procedure was rated at least as high as that in the control group. An even higher estimation can be expected once the technical and organizational problems of such an innovation have been resolved, and when the full potential of the MIGTS is accepted as routine.

In the future, the MIGTS promises increased efficacy in multiple trauma emergency treatment as a result of the 40 per cent increase achievable by treating all patients in the MIGTS, and by using the MIGTS as the resuscitation room as well. This further treatment step has already been embarked on in the authors’ institution. Additional time savings in the treatment of emergency patients may be possible without compromising safety, as thoracic or pelvic radiography and Focused Assessment with Sonography in Trauma (FAST) ultrasound examination may be skipped in favour of immediate multislice CT. Prospective controlled studies will have to confirm these first reports, with the ultimate goal of reducing the mortality and morbidity of multiply injured patients.

The investigated high-technology setting will not easily be transferable to varying needs worldwide. This investigation was designed as a controlled study, using the MIGTS for the treatment of patients whenever it was available. From a methodological approach, pure randomization would have been the preferred design, but in the present study this would have been possible only when the MIGTS was available and not occupied by other patients, resulting in the loss of at least one-quarter of the patients. An unrealistic prolongation of the study period would have been the consequence as it was not possible to use the MIGTS for emergency multiple trauma procedures alone. Although the analysis of confounding variables did not reveal any bias in favour of one study group, it was not possible to exclude all other confounders. The time of day of the procedure could have been a main biasing factor, as ongoing procedures blocked the MIGTS for emergency trauma treatment mainly during daytime. However, an almost equal distribution of daytime or workday cases was observed between the two study groups.

This study did not consider the possible economic consequences of the MIGTS, an important aspect in the light of the already substantial investment in initial establishment of the MIGTS, estimated to be approximately €3 million at the time of this study, including all necessary modifications of existing constructions. Although routine MIGTS use did not require any additional staff, the implementation of such an infrastructure in daily routine is costly. Currently, the possibility that the MIGTS might incur increased costs without beneficial results cannot be refuted. Interestingly, in Switzerland, this capital expenditure can already be justified by preventing the lifelong disability of three multiply injured patients. As a significant difference in the length of stay or 2-year outcome of patients could not be demonstrated, detailed health-related economic evaluation was not examined further and must await the expected implementation of future evaluations on the basis of these preliminary results.

The authors’ initial experience indicates that an improvement in mortality rates and long-term outcome of multiply injured patients can be anticipated for emergency management in the MIGTS if four major conditions are met: complete use of the structural and organizational potential of the MIGTS; optimization of technical interfaces; adequate interdisciplinary training of staff; and critical integration of clinical experiences and feedback from care providers in further development of multiple trauma treatment in the MIGTS. A randomized comparison of conventional management versus treatment of multiple trauma patients in the MIGTS in a large level I centre should provide further evidence for the expected clinical effectiveness and efficiency of the procedure.

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