AO COIAC
COmprehensive Injury Automatic Classifier

Software for the classification and documentation of injuries

User Manual Version 4.0.0

Pediatric Database Extension

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Important Note and Disclaimer:
We cannot guarantee 100% that this software is problem-free and will work adequately on your computer. Please carefully read this user manual before installation and use. The AO Foundation cannot take responsibility for any damages or inconveniences that may occur by using this software version. For use of the AO COIAC software and its manual the AO Foundation terms, conditions and disclaimers apply (www.aofoundation.org)
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1. Introduction

The AO Foundation developed the software named AO COIAC (AO COMprehensive Injury Automatic Classifier) to facilitate the diagnosis, coding and documentation of injuries. This release version includes the long bone fracture classification (adult and paediatric) as well as the new AO CMF fracture classification. For pediatric long bone fractures, a database extension has been developed for full documentation including health status, treatment, complications and outcomes.

This manual highlights the structure and content of the pediatric database extension. The general features of the software for classification are presented in a separate manual.

2. Pediatric documentation database

The pediatric documentation database extension offers four additional software tabs after classification of a pediatric fracture:

- **Health tab**: baseline injury and health parameters required for treatment decision
- **Treatment tab**: treatment parameters (pre-treatment immobilization, primary treatment, implants, post-operative immobilization, patient mobilization, implant removal)
- **Complication tab**: local and general complications with pre-defined list of non-unexpected events or device effects
- **Outcome tab**: selected list of clinically-relevant outcome for pediatric patients
Screenshot examples are presented in Figure 1. A more detailed presentation is made in the following sections of this manual.

Figure 1

Health tab

Treatment tab

Complication tab

Outcome tab

2.1. Health status tab

The health tab includes all parameters to describe the physical and health status of the patient at the time of treatment decision, usually at or shortly after the trauma event.

2.1.1. Patient-level parameters

Patient level parameters are presented in a specific sub-tab section:

Patient characteristics (Figure 2)

- **Weight**: the unit in kilogram (kg) or pounds (lbs) can be selected and will be presented subsequently as default.
- **Height**: the unit in meter (m), centimeter (cm), inches (in) or feet (ft) can be selected and will be presented subsequently as default.
- **BMI**: once the weight and height are entered, the Body Mass Index of the patient is calculated automatically (Weight / Height²)
Pre-existing health conditions (Figure 3)

Concomitant disease: in case of pre-existing concomitant disease, this section will be activated for specification of the health condition:
- Osteogenesis imperfecta, Arthrogryposis, Dysraphism (MMC)
- Neuromuscular, Metabolism disease
- Other concomitant disease(s) along with an open text for specification.

Additional fracture(s) (Figure 4)

In case of additional fracture(s) other than long bone fractures, their location can be specified:
- Spine, Hand, Clavicle, Pelvis, Foot,
- Other location(s) along with an open text for specification

Additional injuries (Figure 5)

In case of additional injuries, their location can be specified:
- Head, Maxillofacial, Thoracic, Abdominal, Urogenital
- Peripheral nerves, Soft tissue other than at the fracture site(s)
- Other additional injury, along with an open text for specification
Additional joint dislocation (Figure 6)

In case of joint dislocation(s), the involved joint(s) can be specified separately for the right and left sides:
- Upper extremity: sterno-clavicular joint, acromio-clavicular joint, shoulder, elbow, wrist
- Lower extremity: hip, patella, knee, ankle

Figure 6

<table>
<thead>
<tr>
<th>Additional joint dislocation</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper extremities</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>Sterno clavicular</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acromio clavicular</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoulder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elbow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wrist</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.1.2. Bone-level parameters

Bone level parameters are related to the injured bone(s) and are presented in specific sub-tabs for each injured bone. If multiple injuries located in several bones are recorded, one sub-tab for each injured long bone is presented:

Diagnostic overview (Figure 7)

The diagnostic overview window presents the fracture classification (diagnosis) on which the treatment decision is made.
If only one classifier is involved, he/she is selected automatically
If two or more classifiers are involved, a drop-down menu allows the selection

The selected classifier generates what is considered the valid code for the database; subsequent treatment, complication and outcome data will be related to this diagnosis. Note that this valid code still can be corrected after treatment if justified by newly gained clinical information, such as during an operation.

As long as no treatment has been recorded, the valid diagnosis for each module is that provided last by any of the registered users/classifiers. When treatment is recorded (see next section) the diagnosis on which the treatment is based becomes the valid diagnosis for the database.

Figure 7
Lesions other than fractures (Figure 8)

Fracture mechanism: pathological fracture, and in this case it can be specified if this is a bone cyst (as one type of pathological fracture) or not.

Skin lesion: Open/closed skin injury, along with related classification:
- Gustilo classification for open fractures
  Type I (Wound < 1 cm) / Type II (Laceration > 1 cm) / Type III (Extensive damages)
- Classification for closed fractures
  None / Skin contusion / Skin abrasion

Other soft tissue lesions:
- Lesion of nerve with specification according to extremity:
  - Upper extremity: medialis, ulnaris, radialis nerve
  - Lower extremity: ischialicus, peroneus, femoralis nerve
- Lesion of artery
- Other soft tissue lesion along with an open text field for specification

Additional joint dislocation:
If in the sub-tab “Patient level” the parameter “additional joint dislocation” is specified as “Yes” (Figure 6), the related joints will be presented for specification in the respective bone sub-tabs. For instance in a sub-tab related to a tibia fracture (Right or left side), the ankle, patella and knee joints are listed.

Note: specification of a joint dislocation in the “patient level” tab is automatically specified in the respective bone sub-tabs as well.

Figure 8

<table>
<thead>
<tr>
<th>Pathological fracture</th>
<th>Yes</th>
<th>No</th>
<th>Bone cyst</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injury</td>
<td>Open</td>
<td>Closed</td>
<td>Soft tissue classification</td>
<td>Skin contusion</td>
<td></td>
</tr>
<tr>
<td>Lesion of nerve</td>
<td>Yes</td>
<td>No</td>
<td>Ischialicus</td>
<td>Peroneus</td>
<td>Femoralis</td>
</tr>
<tr>
<td>Lesion of artery</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other soft tissue lesion</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional joint dislocation</td>
<td>Ankle</td>
<td>Patella</td>
<td>Knee</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.2. Treatment tab

The treatment tab contains all parameters to document the injury treatment.

Note = Hospitalization dates must be recorded within the history tab as described in the main AO COUAC user manual.

2.2.1. Bone-level treatment parameters

Bone-level treatment parameters are specific to each injured long-bone and are presented in specific sub-tabs. Click on the tab label to view its content.
Diagnostic overview

A diagnostic overview (Figure 2) window allows checking on the fracture classification on which is based the treatment choice. If more than one classifier provided their diagnosis, the valid code can be selected via a dropdown menu.

The treating surgeon can be selected independently from the leading classifier (i.e. classifier providing the valid classification code) using a drop-down list of registered surgeons. If the treating surgeon is not available from the list, he/she can be registered by the AO COIAC administrator.

Reminder = by double-click within this section or clicking on the arrow on the top-right corner of the section window, the illustrations will be hidden or shown accordingly.

Figure 9

Pre-treatment / main treatment

Pre-admission treatment (Figure 10) occurred when the patient was treated prior to the main treatment. In such situation, after selecting “Yes”, a drop-down menu allows specification of one of three options:
- Simple immobilization without reduction
- Reduction without osteosynthesis
- Any kind of osteosynthesis

Figure 10
The main treatment date must be specified (Figure 11). The time window hour of the start of the treatment can be specified (a) at or after the time of the injury event (see Patient Tab). The time between the injury event and the start of treatment is calculated in days and hours accordingly. An error message is presented is the time of main treatment is specified before the time of injury event (b).

Figure 11

a) 

b) 

Quality checks: An invalid date is set to blink in orange when:
- The date is before that of the injury event
- The date is before that of hospital admission when no discharge date is specified
- The date is outside any registered hospitalization period (c)

The main treatment is selected as non-operative or operative (Figure 12). An operation is defined when the treating surgeon makes a hole in the skin (injections do not apply).

For any type of treatment, the following parameters are recorded:

Anesthesia type (drop-down menu)
   None / General anesthesia / Nerve block / Fracture anesthesia
   Awake i.v. sedation / Other along with an open text field for specification

Duration of intervention (min) defined as:
   Non-operative: time taken for the primary immobilization (eg casting)
   Operative: time from skin incision to skin closure

C-arm time (fluoroscopy) (min or cGy x cm2)
Non-operative interventions are further described as (Figure 12):

Fracture reduction (drop-down menu)
None only fixation / Manipulation / Traction / Cast (wedge)

Fracture fixation (drop-down menu)
None / Ready-made-splint / Cast splint / Plaster of Paris / Scotch cast / Cuff and collar

Other non-operative intervention along with an open text field for specification

With operative interventions the parameters related to non-operative interventions are hidden, and a new section is activated to record operation details, i.e. used implants, additional local procedures and intra-operative findings.

For bone sub-tabs with paired bones, i.e. Radius/Ulna and Tibia/Fibula, the used implants are recorded separately for each fractured bone. For instance in Figure 13 involving a radius fracture, the implant parameters for the un-fractured ulna are deactivated. With only one bone, e.g. Humerus and Femur sub-tabs (Figure 14), implants can be documented for that bone.
The following implants are listed:

**Isolated solid and cannulated screw(s)**
- The number of both screws of various sizes can be specified
  - 2.7 / 3.5 / 4.0 / 4.5 / 6.5-7 mm

**K-wire(s)**
- The number of K-wire(s) of various sizes can be specified
  - 1.2 / 1.4 / 1.6 / 1.8 / 2.0 / 2.5 / 3.0 mm

**Plate, along with its type** (drop-down menu)
- DCP / LC-DCP / LCP / Tubular / Reco / Hip plate-Angle plate

**Elastic nail(s)**
- The number of elastic nail(s) of various sizes can be specified
  - 1.5 / 2.0 / 2.5 / 3.0 / 3.5 / 4.0 / >4.0 mm
- Use of elastic nail End Cap(s)

**Rigid nail / Expert nail**

**Wire-loop**

**External Fixator (FixEx), along with its type** (drop-down menu)
- Unilateral / Circular / Small FixEx /
- Other FixEx along with an open text field for specification

**Resorbable implant(s)**

**Additional local operative procedures are** (Figure 15):
- Tourniquet / Debridement / Drainage
- Skin left open; the date of skin closure can be specified
- Tendon / Ligament / Vessel / Nerve repair
- Arthrography-Arthroscopy
- Other local procedure, along with an open text field for specification
Clinically-relevant intra-operative findings are (Figure 15):
- Interposition muscle
- Bone defect
- Joint instability
- Visible Joint Cartilage damage (only in case of intra-articular fracture)

Figure 15

By double-click on the implant section, most parameters will be hidden and only summary of the implant used and additional procedure(s) is presented (Figure 16).

Figure 16

In case of operative intervention, additional immobilization to the used implant can be specified (Figure 17):
- **Reason** (drop down menu)
  - Age-disabled patient / Fracture protection / Pain at fracture site / Joint instability / Additional Injury
- **Type** (drop down menu)
  - Splint / Plaster of Paris / Sling / Brace / Other immobilization type, along with an open text field for specification
- **Duration** in weeks (drop down menu)
  - 1 / 2 / 3 / 4 / 5 / 6 / >6

Figure 17
Post-treatment mobilization

The post-treatment mobilization (Figure 18) is specified by drop-down menu according to upper or lower extremity involvement in a separate section as:
- Rest (no mobilization / bed rest)
- Only passive motion
- Free movement but no carrying / no weight bearing
- Partial weight bearing (carry of bags / use of walking aids)
- Full weight bearing (on the hands / free walking)

For injury of the lower extremity, it is specified if the child was walking before the injury (b).

If mobilization is restricted, the reason is specified by drop-down menu as:
- Due to the fracture(s) / Child himself / Social / Fixation stability /
- Bone quality / Soft tissue

**Figure 18**

a) 

<table>
<thead>
<tr>
<th>Post-treatment mobilization</th>
<th>Reason for restricted mobilization</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Due to the stability</td>
</tr>
</tbody>
</table>

b) 

<table>
<thead>
<tr>
<th>Post-treatment mobilization</th>
<th>Was the child walking before the injury event?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Only passive motion</td>
<td></td>
</tr>
<tr>
<td>Reason for restricted mobilization</td>
<td>Due to the stability</td>
</tr>
</tbody>
</table>

**Implant removal**

When one or more implants are specified, the implant removal is documented in the last section (Figure 19).

The planned removal is specified as partial or full by drop-down menu.

The effective removal is confirmed as partial or full, as well as whether it was performed because it was planned or it followed a complication.

**Figure 19**

<table>
<thead>
<tr>
<th>Implant removal</th>
<th>Planned implant removal</th>
<th>Reason for planned removal</th>
<th>Implant removal removed</th>
<th>Reason for implant removal removed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
<td>full</td>
<td>reason</td>
</tr>
</tbody>
</table>
2.2.2. Patient-level treatment parameters

Patient-level treatment parameters are related to the patient and are presented in a specific sub-tab. Additional treatments (Figure 20) to those performed at the injured bones are specified.

**Additional local surgical procedures during the same anesthesia:**
- Cranium Brain / Maxillofacial / Thorax / Abdomen /
- Other Bones than long bones, along with an open text field for specification

**Medical treatment**
- Antibiotic prophylaxis
- Thromboembolic prophylaxis
- Blood transfusion

**Figure 20**

<table>
<thead>
<tr>
<th>Patient level</th>
<th>2- Radius / Ulna (Right)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Additional treatment</strong></td>
<td>Yes / No</td>
</tr>
<tr>
<td>Additional local proc. during same anesthesia:</td>
<td></td>
</tr>
<tr>
<td>□ Cranium Brain</td>
<td>□ Maxillofacial</td>
</tr>
<tr>
<td><strong>Medical treatment:</strong></td>
<td></td>
</tr>
<tr>
<td>□ Antibiotic prophylaxis</td>
<td>□ Thromboembolic prophylaxis</td>
</tr>
</tbody>
</table>

2.3. Complication tab

For any injured long bone, the complication tab allows recording complications occurring after the initiation of the main treatment. A standardized approach to the documentation of these complications has been developed at AOCD and is made available in this database tab.

**Complication / Adverse event definition**

In the context of Good Clinical Practice guidelines, an Adverse Event (AE) is defined as any untoward medical occurrence in a patient which does not necessarily have a causal relationship with the treatment or implant. It can therefore be any unfavourable and unintended sign (including an abnormal laboratory finding), symptom, or disease. In the context of clinical documentation, we may consider recording only “complication” that may be assessed as clinical relevant for the fracture treatment. The term "complication" is however not well defined.

**Recording the first complication**

By accessing the complication tab, the first complication form is presented with the identification 1-A, however most fields are de-activated (Figure 21).
Location and timing

The location of the complication is first specified by drop-down menu (Figure 22), either local to an injured bone (for which a treatment date is documented) or the rest of the body (referred also to as “general” complications).

By selecting an injured bone, the complication is defined as being local to the injury. A number of parameters are then activated:

- Intra-operative complications can be documented if the recorded treatment for the related injured bone is operative (see treatment tab). In case of an intra-operative complication, the Date and Period fields are de-activated (a).

- For complications that are not intra-operative (i.e. “post-operative” or after initiation of the main non-operative treatment), the date of occurrence (or onset) can be recorded. The
default date is set as the date of the main treatment; however it must be confirmed and changed as appropriate (b).

As this date may not be exactly known, at least the period of occurrence (or onset) must be recorded by pull-down menu according to one of the following:

- < 1 m (up to one month)
- 1 m – < 3 m (one to three months)
- 3 m – < 6 m (three to six months)
- 6 m – < 1 y (six months to one year)
- 1 y – < 2 y (one to two years)
- > 2 y (2 years and more)

Note that if the complication date is specified, the corresponding period of occurrence is determined automatically (c).

- If the treatment is registered as non-operative for a given injured bone, the complication can only be specified as “post-treatment” (after the initiation of non-operative treatment). The field “Intra-operative” is de-activated (e)

- If the complication is regards the rest of the body (i.e. none of the registered fractured long bones), the period of occurrence is based on the first main treatment date recorded for any injured bone (f).

**Complication specification / description**

In AO COIAC, non-unanticipated complications are pre-registered for selection in one of four classes (Figure 23 - a):

- 1-Treatment / Implant / Surgery
- 2-Bone / fracture
- 3-Soft tissue / Wound
- 4-General / Rest of the body

**Figure 23**

<table>
<thead>
<tr>
<th>a)</th>
<th>Class: Treatment / Implant / Surgery</th>
<th>Description: Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Details: Specify the complication here!</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>b)</th>
<th>Class: Treatment / Implant / Surgery</th>
<th>Description: Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Details: Specify the complication here!</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Secondary implant perforation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Implant failure / breakage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>implant loosening with loss of reduction / stability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>c)</th>
<th>Class: Treatment / Implant / Surgery</th>
<th>Description: Secondary implant perforation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Details: Specify the complication here!</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Through the bone</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Through the skin</td>
</tr>
</tbody>
</table>
After the complication class is selected, the description can be specified by drop-down menu (b) presenting a list of non-unanticipated complications, as well as further specifications (c). Further details about the complication can be documented in an open text field.

Non-unanticipated intra-operative complications are listed in Table 1. Non-unanticipated post-operative complications (operative treatment) or complications occurring after initiation of non-operative treatment are listed in Table 2. Along with non-unanticipated complications, in AO COIAC the option “Other” is available for description of any other complication.

In case of non-operative treatment complications related to operative interventions (i.e. intra-operative complications or implant problems) remain hidden.

**Cause and severity**

The most likely cause of the complication is further documented by drop-down menu (Figure 24) by one of the following options, as well as by specification in an open text field:

- Lack of primary reduction / Insufficient primary reduction / Loss of primary reduction
- Insufficient non-operative immobilization technique
- Lack of internal fixation (operative necessity)
- Insufficient immobilization technique / Preterm mobilization
- [Bone / fracture / injury] / Patient related

The severity of the complication (a) can be rated as:

- **Mild**: The patient is aware of the event or symptom but the event/symptom is easily tolerated. No additional treatment required
- **Moderate**: The patient experiences sufficient discomfort to interfere with or reduce his/her usual level of activity. Additional non-operative treatment is required
- **Serious / Severe**: Significant impairment of functioning; the patient is unable to carry out usual activities. Operative intervention is required

**Figure 24**

<table>
<thead>
<tr>
<th>Figure 24</th>
<th>a)</th>
<th>b)</th>
<th>c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most likely cause:</td>
<td>Bone / fracture / injury</td>
<td>Insufficient operative technique</td>
<td>Bone / fracture / injury</td>
</tr>
<tr>
<td>Severity:</td>
<td>Serious / Severe</td>
<td>Moderate</td>
<td>Serious / Severe</td>
</tr>
<tr>
<td>Adverse device effect:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If an implant was used, the relation to the implant can be further considered by specifying the likelihood of the complication being an “Adverse device effect” as Definitively, Likely, Probably, Possibly, Unlikely, or Unrelated (b). This option is de-activated if no implant was used (c).
### Table 1: Non-unanticipated intra-operative complications

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
<th>Specification</th>
<th>Definition / Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Treatment / Implant / surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Primary implant perforation*</td>
<td></td>
<td>Implant into a joint as seen on X-rays through the bone Only if use of Elastic Nail(s)</td>
</tr>
<tr>
<td>2</td>
<td>Bone / fracture</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Iatrogenic fracture</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Primary insufficient fracture reduction or fixation*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Soft tissue / wound</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bleeding requiring additional intervention</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* requiring secondary intervention

### Table 2: Non-unanticipated post-operative (or non-operative treatment) complications

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
<th>Specification</th>
<th>Definition / Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Treatment / Implant / surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Secondary implant perforation*</td>
<td></td>
<td>Implant into a joint as seen on X-rays through the bone Only if use of Elastic Nail(s) or K-wire(s)</td>
</tr>
<tr>
<td></td>
<td>Implant breakage</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Implant loosening with loss of reduction / stability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Bone / fracture</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Loss of reduction / stability</td>
<td></td>
<td>Any change in fragment position seen on treatment and follow-up X-rays (no implant loosening)</td>
</tr>
<tr>
<td></td>
<td>Delayed healing / nonunion</td>
<td></td>
<td>Insufficient signs of healing &gt; 3 months (delayed-healing) or &gt; 6 months (nonunion)</td>
</tr>
<tr>
<td></td>
<td>Osteomyelitis</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Secondary Fracture</td>
<td></td>
<td>Fracture occurring at the same bone</td>
</tr>
<tr>
<td></td>
<td>Re-fracture</td>
<td></td>
<td>Fracture occurring at the same location at a load level otherwise tolerated by normal bone &lt; 8 months</td>
</tr>
<tr>
<td></td>
<td>Malunion*</td>
<td></td>
<td>Bone unites in abnormal position</td>
</tr>
<tr>
<td></td>
<td>Local pain*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Soft tissue / wound</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wound hematoma*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Superficial wound infection</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Deep wound infection</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pin track infection</td>
<td></td>
<td>Only if use of External fixateur</td>
</tr>
<tr>
<td></td>
<td>Joint haematoma or infection</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Delayed wound healing (dehiscence / necrosis)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Compartment syndrome</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>General (rest of the body)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Infection</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sepsis</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thrombosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Emboli</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Death</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* requiring secondary intervention
Treatment

The treatment of the complication (Figure 25) can be recorded as non-operative (a), which can be "New reduction and casting" or "Wedging cast", or operative.

The type of the operation is specified by drop-down menu (b) as:

Revision  Procedure that adjusts or in any way modifies or remove part of the original implant configuration, with or without replacement of a component. A revision may also include adjusting the position of the original configuration.

Removal  Procedure where all of the original implant configuration is removed with or without replacement.

Supplemental fixation  Procedure in which additional implant(s) is used

(Re)operation  Any surgical procedure that does not involve removal, modification, or addition of any components to the implant configuration.

The date of the operative intervention is recorded

Figure 25

a)  

Treatment:  

- Non operative
- New reduction and casting
- Wedging cast
- Operative
- External fixator
- Elastic nails
- K-wire(s)
- Screw(s)
- Other implant(s)
- Debridement
- Fasciectomy
- Other surgical procedure
- Additional immobilization
- Antibiotics
- Anticoagulation
- Other

b)  

Treatment:  

- Non operative
- New reduction and casting
- Wedging cast
- Operative
- External fixator
- Elastic nails
- K-wire(s)
- Screw(s)
- Other implant(s)
- Debridement
- Fasciectomy
- Supplemental fixation
- Other surgical procedure
- Additional immobilization
- Revision
- Removal
- Internal fixation
- Other

In case of operative revision, removal or supplemental fixation, one or more of the following options can be specified (Figure 26):

- External fixator
- Elastic nail(s)
- K-wire(s)
- Screw(s)
- Other implant(s)

Figure 26
In case of (full) removal (Figure 27 a), this information might be already documented in the treatment tab (b) when removal is caused by a complication. In such situation, it can be mentioned in the complication tab that this is the same operative intervention (c). When selected, the date of removal will be automatically registered (d).

**Figure 27**

**a)**
- Operative: Yes
- Type: Removal
- Is this removal as mentioned in the treatment: Yes
- Date: 09.09.2008

**b)**
- Planned implant removal: Yes
- Implant removal performed: Yes
- Date: 10.10.2008
- Time after main treatment: 1 month(s), 21 day(s)

**c)**
- Operative: Yes
- Type: Removal
- Is this removal as mentioned in the treatment: Yes
- Date: 09.09.2008

**d)**
- Operative: Yes
- Type: Removal
- Is this removal as mentioned in the treatment: Yes
- Date: 10.10.2008

In case of a (re)operation not involving implants, one or more of the following options can be specified (Figure 28):
- Debridement
- Fasciotomy
- Other surgical intervention, along with an open text field for specification

**Figure 28**

**Figure 29**

Finally, other interventions are documented by one or more of the following options (Figure 29):
- Additional immobilization
- Treatment with antibiotics
- Anticoagulation therapy
- Other treatment

An open text field is available to report any additional comment about the complication

**Figure 29**

Note = AO COIAC considers the primary treatment as the most important. If a change of treatment was implemented following a complication, the new treatment cannot currently be recorded in as much details as for the primary treatment.
Recording additional complication(s)

Additional complications related to the same injury event can be documented similarly in the complication tab. A new complication form is activated by clicking on the icon on the tab bar. The complication identification 2-A is automatically given (Figure 30).

Reminder = if the icon is de-activated (b), this means AO COIAC moved into browse mode and you need to activate the edit mode, either by pressing F2 or the lock icon on the tab bar.

Figure 30

In AO COIAC, a second complication can be registered as being unambiguously directly related to another complication that is already documented; the related complication number should then be specified (Figure 31). The identification of the second related complication is set as 1-B, instead of 2-A.

Figure 31
Deleting a complication

A complication form can be deleted by clicking on the delete icon, followed by active confirmation (Figure 32).

Figure 32

The numbering of complications is always adapted according to newly added complication forms, causal relationship settings between complications, deleted complications, and their date and period of occurrence (Figure 33).

Figure 33

2.4. Outcome tab

The outcome tab is set to document clinically relevant outcomes related to the bone anatomy, healing process, function, and the patient return to activity and satisfaction.

Note = Outcome parameters for any follow-up can only be recorded after the corresponding follow-up examination date is recorded in the history tab (see main AO COIAC user manual).

In the Outcome Tab, the documentation of outcome variables is "dynamic", i.e. a user can record as many repeated measures of outcome as the follow-up of a patient requires.
Outcome parameters are set with 5 rows for visualization of successive measurements for a given outcome. If more than 5 measures are entered (i.e. >5 visits), the user will be able to scroll within each outcome module to see all records (Figure 34).

Note = if multiple injuries are treated at different dates as documented in the treatment tab, the follow-up time after initiation of main treatment must be calculated separately for each bone. The timing presented in this outcome tab is related to the injury event.

2.4.1. Bone-level outcome parameters

For each injured long bone, the following sections are available (Figure 34):
- Diagnostic overview
- Bone healing status (X-ray evaluation)
- Range of angulation and displacement (X-ray evaluation)
- Clinical evaluation of leg length (lower extremity)
- Final examination of elbow axis (upper extremity)
- Active range of motion (Zero-neutral method)
- Functional ability and weight bearing
- Local pain (Bieri pain scale)

The diagnostic overview section presents the fracture classification as in the health status and treatment tabs (see sections 2.1 and 2.2).
Bone healing status

The bone healing status is documented from the X-rays after the initial post-treatment examination (Figure 35) in one of five categories:

- No visible callus
- Visible callus
- Complete callus bringing (consolidation)
- Partial remodeling
- Full remodeling

Figure 35

The radiological outcomes

The radiological outcomes can only be documented if X-rays are available (Figure 36); the related fields for examination lacking the required X-rays are de-activated.

The range of angulation is documented by selecting appropriate boxes in 10° intervals for:

- Varus – Valgus
- Antecurvation - Recurvation

Clinically-relevant angulation is defined as an angulation > 10°

Fracture displacement is document relative to the shaft diameter

- \( \leq \frac{1}{2} \) shaft
- \( > \frac{1}{2} \) shaft

Visible steps in the articular surface can be documented for intra-articular (/E) fractures

Note that in all sections, when parameters can be recorded over more than one examination, the clinical relevance of any changes must be carefully considered as a quality check (e.g. a bone angulation is unlikely to change from severe varus to severe valgus from one examination to the next)
Clinical evaluation of elbow axis

In case of fracture of the upper extremity, the elbow axis at both injured and contra-lateral sides is examined clinically (no X-rays required) at the final examination (Figure 37). The varus/valgus angulation is documented by check boxes of 10° range; the normal anatomy is considered in the range 0° to 10° valgus.

Clinical evaluation of leg length

In case of fracture of the lower extremity, the leg length at both injured and contra-lateral sides is examined clinically at the final examination (Figure 38). Leg shortening or lengthening is documented by check boxes; the normal anatomy is considered in the range +/- 1cm.
Figure 38

<table>
<thead>
<tr>
<th>Clinical evaluation of leg length</th>
<th>{discrepancy with uninjured healthy contra-lateral leg}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the contra-lateral leg length remain unaffected by the injury or any pathology?</td>
<td>Yes  No</td>
</tr>
<tr>
<td>Examination time after trauma</td>
<td>Shortening</td>
</tr>
<tr>
<td>Follow-up 1 0 month(s), 14 day(s)</td>
<td>&gt;2 cm</td>
</tr>
<tr>
<td>Follow-up 2 1 month(s), 17 day(s)</td>
<td></td>
</tr>
<tr>
<td>Follow-up 3 2 month(s), 9 day(s)</td>
<td></td>
</tr>
<tr>
<td>Follow-up 4 3 month(s), 26 day(s)</td>
<td></td>
</tr>
<tr>
<td>Follow-up 5 5 month(s), 15 day(s)</td>
<td></td>
</tr>
</tbody>
</table>

Active range of motion

The active range of motion on the injured and contra-lateral side is documented using the zero-neutral method. Only the joints adjacent to the injured bone are presented in the respective bone and range of motion sub-tabs (Table 3).

Table 3: Range of motion (ROM) parameters according to injured bones

<table>
<thead>
<tr>
<th>Range of motion</th>
<th>Bones</th>
<th>Humerus</th>
<th>Radius / Ulna</th>
<th>Femur</th>
<th>Tibia / Fibula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoulder internal-external rotation</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elbow flexion-extension</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wrist flexion-extension</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wrist radial abduction–ulnar abduction</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wrist pronation-supination</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hip internal-external rotation (back position)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hip internal-external rotation (face position)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knee flexion-extension</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ankle Plantar flexion-Dorsal extension</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Considering the knee flexion-extension in Figure 39 the ROM is recorded separately for the injured and contra-lateral side. Their side is automatically presented according to the injured bone.

It is specified by check boxes if the contra-lateral bone is healthy or not; an unhealthy side cannot be used as reference value for the patient.

The examiner specifies by check boxes if a motion deficit on the injured side is suspected or not; in daily clinical context this allows documenting “normal” ranges without having to report actual measurements. In case of suspicion or in the context of clinical research the ROM should be reported.
Figure 39

<table>
<thead>
<tr>
<th>Examination time after trauma</th>
<th>Contro lateral side</th>
<th>Injured side</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Follow-up 1 0 month(s), 14 day(s)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Follow-up 2 1 month(s), 17 day(s)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Follow-up 3 2 month(s), 9 day(s)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Follow-up 4 3 month(s), 26 day(s)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Follow-up 5 5 month(s), 15 day(s)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Note: Users should pay attention to the order of measurements in the Zero-neutral-method; here first the flexion, then the neutral angle, and last the extension!

Functional ability and weight bearing

The allowed mobilization of the injured extremity is documented by drop-down menu for each follow-up examination (Figure 40). In case of restriction, the reason can be specified as well. These fields are similar to those presented in the treatment tab, and the post-treatment mobilization information is reported in this section for reference.

Figure 40

<table>
<thead>
<tr>
<th>Examination time after trauma</th>
<th>Child walking before the injury event</th>
<th>Post treatment mobilization</th>
<th>Examination time after trauma</th>
<th>Allowed mobilization</th>
<th>Reason for restricted mobilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Follow-up 1 0 month(s), 14 day(s)</td>
<td>Yes</td>
<td>Free movement, but no weight bearing</td>
<td></td>
<td>Free movement, but no weight bearing</td>
<td>Due to the fracture</td>
</tr>
<tr>
<td>Follow-up 2 1 month(s), 17 day(s)</td>
<td></td>
<td>Partial weight bearing (use of walking aids)</td>
<td></td>
<td></td>
<td>Due to the fracture</td>
</tr>
<tr>
<td>Follow-up 3 2 month(s), 9 day(s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Due to the healing process</td>
</tr>
<tr>
<td>Follow-up 4 3 month(s), 26 day(s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Follow-up 5 5 month(s), 15 day(s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pain level

The level of local pain at rest and at allowed motion is documented at each follow-up examination using the Bieri scale (Figure 41). This scale is validated for use with children and ranges from 1 (no pain) to 6 (worst possible pain).
2.4.2. Patient-level outcome parameters

At the patient level, the following sections are available (Figure 42):
- Child’s return to full unrestricted activities
- Overall level of satisfaction

**Figure 42**

**Child’s return to full unrestricted activities**

It can be specified if the patient returned to (i.e. was allowed to) full unrestricted activities (e.g. school sport), and the date when this occurred.

**Overall level of satisfaction**

The overall level of satisfaction with the treatment is documented using a NRS (0 = not satisfied at all to 10 = fully satisfied) at the final follow-up examination. Both the child and the parents (or tutor) can provide independent ratings.
3. Acknowledgements

This software project was funded by the AO Foundation, AOTrauma and AOUCMF through the activities of the AO Classification Supervisory Committee and its Classification Groups, and implemented by AO Clinical Investigation and Documentation.

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Pediatric Classification Group (PACG)

<table>
<thead>
<tr>
<th>Core group</th>
<th>Other contributors</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td></td>
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</tbody>
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