Generalized Net Model of the Process of Clinical Decision Making in Complex Urethral Stricture and Urethro-Cutaneous Fistulae Treatment

Overview

Clinical cases with crippled hypospadia and urethrocutanous fistulae represent significant and complex health and social problem. Developing an optimal clinical algorithm is one of the most important conditions for successful resolution of this problem. The protocol that we use at the present moment is shown on the figure below.
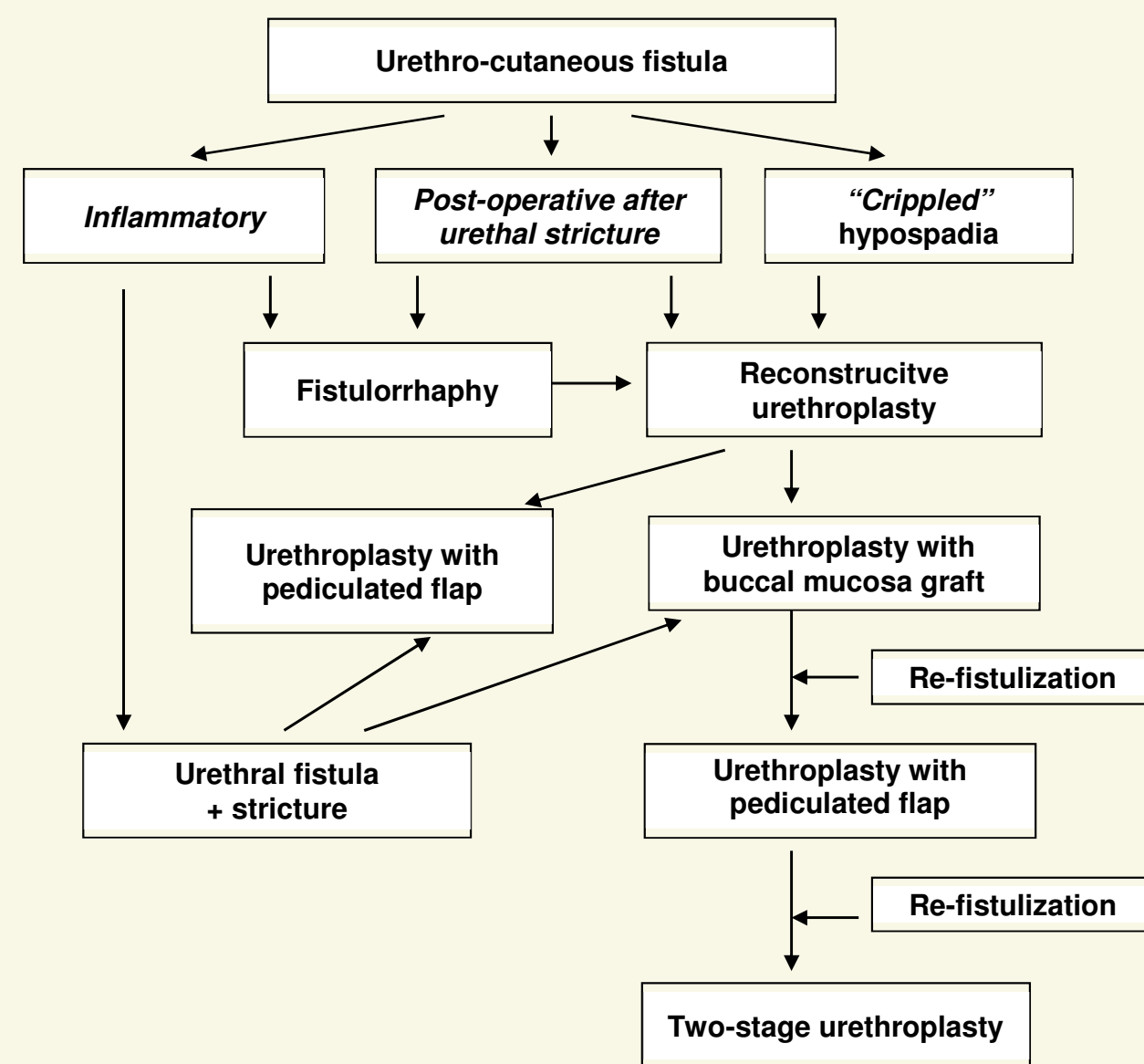

Figure: Protocol currently used for uretrocutaneous fistulae treatment

Generalized net model

The developed GN-model of the process of clinical decision making in complex urethral stricture and urethro-cutaneous fistulae treatment contains 11 transitions and 20 places.
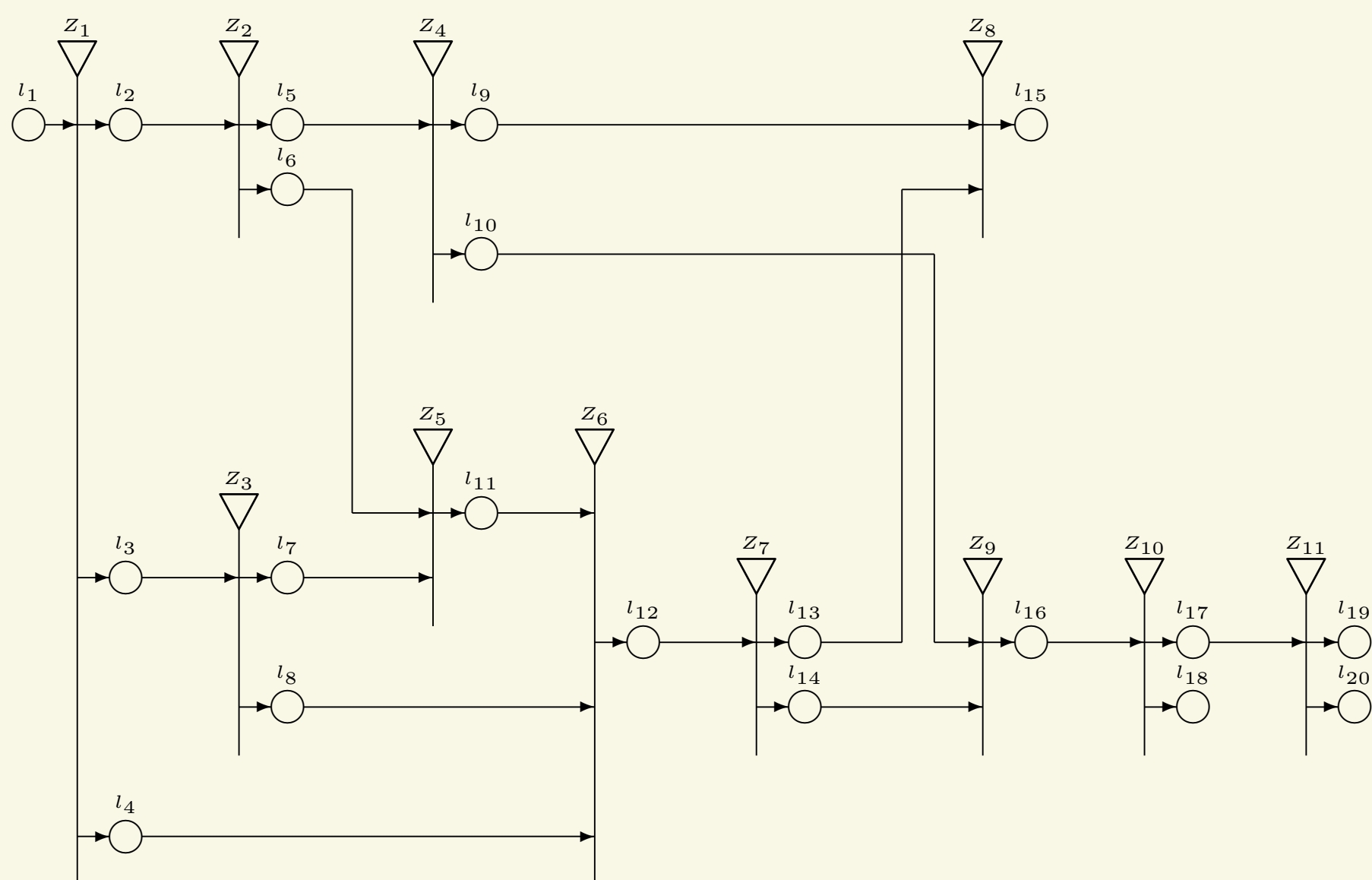

Figure: GN-model of the process of clinical decision making in complex urethral stricture and urethro-cutaneous fistulae treatment

A token representing a patient enters place l_1 with initial characteristic

"Patient with diagnosis for a uretro-cutaneous fistula".

The GN-transitions have the following form:

$$Z_1 = \langle \{l_1\}, \{l_2, l_3, l_4\}, \frac{l_2 \quad l_3 \quad l_4}{l_1 \mid W_{1,2} \quad W_{1,3} \quad W_{1,4}} \rangle,$$

where
$W_{1,2}$ ="The fistulae are in result of inflammation",
$W_{1,3}$ ="The fistulae are in result of urethral stricture surgery",
$W_{1,4}$ ="The fistulae are in result of crippled hypospadia".

$$Z_2 = \langle \{l_2\}, \{l_5, l_6\}, \frac{l_5 \quad l_6}{l_2 \mid W_{2,5} \quad W_{2,6}} \rangle,$$

where
$W_{2,5}$ ="there is a urethral fistula with stricture",
$W_{2,6}$ ="there is a pure urethral fistula".
In place l_5, the token obtains the characteristic

"fistulography is needed",

while in place l_6 it does not obtain any characteristic.

Generalized net model

$$Z_3 = \langle \{l_3\}, \{l_7, l_8\}, \frac{l_7 \quad l_8}{l_3 \mid W_{3,7} \quad W_{3,8}} \rangle,$$

where
$W_{3,7}$ ="postoperative fistula without recurrent stricture",
$W_{3,8} = \neg W_{3,7}$,
where $\neg P$ is the negation of predicate P.

$$Z_4 = \langle \{l_5\}, \{l_9, l_{10}\}, \frac{l_9 \quad l_{10}}{l_5 \mid W_{5,9} \quad W_{5,10}} \rangle,$$

where
$W_{5,9}$ ="there is insufficient vascularization in stricture area",
$W_{5,10}$ ="there is sufficient vascularization in stricture area".

$$Z_5 = \langle \{l_6, l_7\}, \{l_{11}\}, \frac{l_{11}}{\begin{array}{c} l_6 \mid true \\ l_7 \mid true \end{array}} \rangle,$$

The token enters place l_{11} without a new characteristic.

$$Z_6 = \langle \{l_4, l_8, l_{11}\}, \{l_{12}\}, \frac{l_{12}}{\begin{array}{c} l_4 \mid true \\ l_8 \mid true \\ l_{11} \mid true \end{array}} \rangle,$$

The token enters place l_{12} with the characteristic

"reconstructive urethroplasty is needed".

$$Z_7 = \langle \{l_{12}\}, \{l_{13}, l_{14}\}, \frac{l_{13} \quad l_{14}}{l_{12} \mid W_{12,13} \quad W_{12,14}} \rangle,$$

where
$W_{12,13}$ ="there is insufficient vascularization in stricture area",
$W_{12,14}$ ="there is sufficient vascularization in stricture area".

$$Z_8 = \langle \{l_9, l_{13}\}, \{l_{15}\}, \frac{l_{15}}{\begin{array}{c} l_9 \mid true \\ l_{13} \mid true \end{array}} \rangle,$$

The token enters place l_{15} with the characteristic

"urethroplasty with pediculated flap is needed".

$$Z_9 = \langle \{l_{10}, l_{14}\}, \{l_{16}\}, \frac{l_{16}}{\begin{array}{c} l_{10} \mid true \\ l_{14} \mid true \end{array}} \rangle,$$

The token enters place l_{16} with the characteristic

"urethroplasty with buccal mucosa graft is needed".

$$Z_{10} = \langle \{l_{16}\}, \{l_{17}, l_{18}\}, \frac{l_{17} \quad l_{18}}{l_{16} \mid W_{16,17} \quad W_{16,18}} \rangle,$$

where
$W_{16,17}$ ="there is re-fistulization after conducted UPF",
$W_{16,18} = \neg W_{16,17}$.
If $W_{16,17} = true$, the token enters place l_{17} with a characteristic

"urethroplasty with pediculated flap is needed".

In the opposite case, when $W_{16,18} = true$, it enters place l_{18} with a characteristic

"the patient has been healed".

$$Z_{11} = \langle \{l_{17}\}, \{l_{19}, l_{20}\}, \frac{l_{19} \quad l_{20}}{l_{17} \mid W_{17,19} \quad W_{17,20}} \rangle,$$

where
$W_{17,19}$ ="there is re-fistulization",
$W_{17,20}$ ="there is no re-fistulization".
If $W_{17,19} = true$, the token enters place l_{19} with a characteristic

"two-stage urethroplasty is needed".

In the opposite case, it enters place l_{20} with a characteristic

"the patient has been healed".

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