<table>
<thead>
<tr>
<th>藥物</th>
<th>有效治療濃度範圍</th>
<th>Toxic level</th>
<th>適當抽血時間</th>
<th>再抽血時間</th>
<th>注意事項</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amikacin</td>
<td>Peak: life-threatening infection: 25-40 mcg/mL serious infection: 20-25 mcg/mL urinary tract infection: 15-20 mcg/mL Trough: trough &lt; 8 mcg/mL</td>
<td>Peak: &gt; 40 mcg/mL Trough: &gt; 10 mcg/mL</td>
<td>Peak: 30 分鐘靜脈輸注結束後，再等30分鐘抽血 (即靜脈輸注開始後1小時抽血) Trough: 給藥前30分鐘靜脈輸注</td>
<td>1-2天</td>
<td>1. The American Thoracic Society (ATS) recommends <strong>trough levels of  4-5 mcg/mL</strong> for patients with hospital-acquired pneumonia. 2. <strong>Nephrotoxicity</strong> may occur from amikacin peak concentrations persistently greater than 20 to 35 mcg/mL and trough concentrations greater than 8 mcg/mL.</td>
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<tr>
<td>Gentamicin</td>
<td>Peak: life-threatening infection: 8-10 mcg/mL serious infection: 6-8 mcg/mL urinary tract infection: 4-6 mcg/mL Synergy against gram-positive organisms: 3-5 mcg/mL Trough: life-threatening infection: 1-2 mcg/mL serious infection: 0.5-1 mcg/mL</td>
<td>Peak: &gt; 12mcg/mL Trough: &gt; 2 mcg/mL</td>
<td>Peak: 30 分鐘靜脈輸注結束後，再等30分鐘抽血 (即靜脈輸注開始後1小時抽血) Trough: 給藥前30分鐘靜脈輸注</td>
<td>1-2天</td>
<td>1. Obtain drug levels after the third dose unless renal dysfunction/toxicity suspected 若是腎功能異常者，初次採血時間為第三次給藥前即可抽血檢驗。 2. The American Thoracic Society (ATS) recommends <strong>trough levels of 1 mcg/mL</strong> for patients with hospital-acquired pneumonia. 3. <strong>Nephrotoxicity</strong> may occur from gentamicin with persistent peak serum concentrations of more than 12 mcg/mL or trough concentrations more than 2 mcg/mL.</td>
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<tr>
<td>Vancomycin</td>
<td>Peak: 30-45 mcg/mL Trough: at least &gt; 10 mcg/mL(避免發生抗藥性) 15-20 mcg/mL(確定或高度懷疑以下感染: bacteremia, HAP, endocarditis, osteomyelitis) (右側注意事項)</td>
<td>&gt;80 mcg/mL (Toxicity is reported at levels sustained above 80 to 100 mcg/mL)</td>
<td>Trough: 維持或劑量改變後至少2-5天後</td>
<td>2天</td>
<td>1. Therapeutic levels: Trough: 10 mcg/mL. For pathogens with an MIC &lt;1 mcg/mL, the minimum trough concentration should be 15 mcg/mL to meet target AUC/MIC of ≥400(*1). 2. bacteremia, endocarditis, osteomyelitis, meningitis, and hospital-acquired pneumonia caused by S. aureus, trough concentrations of 15-20 mcg/mL are recommended to improve penetration and improve clinical outcomes (Liu, 2011; Rybak, 2009). 3. The American Thoracic Society (ATS) guidelines for hospital-acquired pneumonia and the Infectious Disease Society of America (IDSA) meningitis guidelines also recommend trough concentrations of <strong>15-20 mcg/mL</strong>.</td>
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<tr>
<td>Carbamazepine</td>
<td>Trough: 4-12 mcg/mL (右側注意事項)</td>
<td>&gt; 15 mcg/mL</td>
<td></td>
<td>2-5天</td>
<td>1. Patient who requires higher level of 8-12 mcg/mL, should be watched closely. CNS side effects (ataxia and nystagmus, ≥12 mcg/mL) occur commonly at higher dosage levels. 2. If other anticonvulsants are given therapeutic...</td>
</tr>
<tr>
<td>藥物</td>
<td>溶血前30分鐘抽血</td>
<td>西揚狀態：初次治療或劑量改變後至少10天後</td>
<td>至少10天</td>
<td>1. 毒性濃度：遲鈍，協調障礙，眼震：35-80 mcg/mL 2. 昏睡與反射：65-117 mcg/mL 3. 昏睡無反射：&gt;100 mcg/mL</td>
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<tr>
<td>Phenobarbital</td>
<td>Trough：成人：20-40 mcg/mL, 嬰兒和兒童：15-30 mcg/mL</td>
<td>至少40 mcg/mL</td>
<td>6-7天</td>
<td>1. After a loading dose: If rapid therapeutic levels are needed, initial levels may be drawn after 1 hour (I.V. loading dose) or within 24 hours (oral loading dose) to aid in determining maintenance dose or need to reload. 2. Rapid achievement: Draw within 2-3 days of therapy initiation to ensure that the patient's metabolism is not remarkably different from that which would be predicted by average literature-derived pharmacokinetic parameters; early levels should be used cautiously in design of new dosing regimens 3. Second concentration: Draw within 6-7 days with subsequent doses of phenytoin adjusted accordingly 4. If plasma concentrations have not changed over a 3- to 5-day period, monitoring interval may be increased to once weekly in the acute clinical setting 5. In stable patients requiring long-term therapy, generally monitor levels at 3- to 12-month intervals 6. The acutely hospitalized patient should have serum phenytoin and albumin levels measured every 1 to 3 days when receiving intravenous phenytoin 7. 對於某些病患，濃度5-10 mcg/mL即可得到療效 8. Trough concentrations are generally recommended for routine monitoring.</td>
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<tr>
<td>Phenobarbital</td>
<td>Trough：&gt; 30 mcg/mL</td>
<td>至少30 mcg/mL</td>
<td></td>
<td>2. Seizure control: toxicity may occur at 100-150 mcg/mL</td>
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<tr>
<td>Valproic acid</td>
<td>Trough：</td>
<td>至少200 mcg/mL</td>
<td></td>
<td>1. Probability of thrombocytopenia increases with total valproate levels ≥110 mcg/mL in females or ≥135 mcg/mL in males. 2. Seizure control: toxicity may occur at 100-150 mcg/mL</td>
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</tbody>
</table>
| **Digoxin** | **Congestive heart failure: 0.5-0.8 ng/mL**<br>**Arrhythmias: 0.8-2 ng/mL** | **2.0 ng/ml**<br>(*3; 注意事項) | **稳態狀態：**<br>初次給藥或劑量改變後至少 5~7 天後<br>Trough：<br>給藥前 30 分鐘抽血<br>其他時機：<br>口服後 6~8 小時、靜注後 4~6 小時、最理想是給藥後的 12~24 小時。<br> | **3. Mania: risk of toxicity increases at levels >125 mcg/mL**<br>**1. < 0.5 ng/mL; probably indicates underdigitalization unless there are special circumstance**<br>**2. Digoxin serum concentrations should be obtained within 5-7 days (approximate time to steady-state) after any dosage changes. Continue to obtain digoxin serum concentrations 7-14 days after any change in maintenance dose.**<br>**Note:** In patients with end-stage renal disease, it may take 15-20 days to reach steady-state.
### Theophylline

**Therapeutic levels:**
- **Asthma**
  - **Adults:** 5-15 mcg/mL
  - **Children:** 5-10 mcg/mL

**Peak:**
- Traditional formulation: Oral 2 hours post-dosing
- Extended-release formulation: Oral 5 hours post-dosing; IV 30 minutes after bolus

**Steady State:**
- After initial dosing or dose change, within 2-5 days
- 2-5 days

**Toxic Level:**
- Not well defined; nephrotoxicity may occur at any level

**I.V. Loading Dose:**
- Measure serum concentrations 30 minutes after the end of an I.V. loading dose

**I.V. Infusion:**
- Measure serum concentrations one half-life after starting a continuous infusion, then every 12-24 hours

**Monitoring:**
- **Serum Theophylline Levels:**
  - Should be monitored prior to making dose increases; in the presence of signs or symptoms of toxicity; or when a new illness, worsening of a present illness, or medication changes occur that may change theophylline clearance

### Cyclosporine

**Therapeutic range:**
- Not absolutely defined, dependent on organ transplanted, time after transplant, organ function and CsA toxicity.
- **General range of 100-400 ng/mL**
  - (測定方: FPIA)

**Steady State:**
- Initial dosing or dose change at least 3 days
- 3-5 days

**Toxic Level:**
- Not well defined; nephrotoxicity may occur at any level

**Method-dependent and specimen-dependent:**
- Trough levels should be obtained:
  - Oral: 12-18 hours after dose (chronic usage)
  - I.V.: 12 hours after dose or immediately prior to next dose

**Monitoring:**
- **Lab Tests:**
  - LFTs, CBC, cholesterol and triglycerides, serum creatinine, and urinary protein.

### Everolimus

**Renal transplantation:**
- 3-8 ng/mL

**Subependymal giant cell astrocytoma:**
- 5-10 ng/mL

**Heart transplantation (unlabeled use):**
- 3-8 ng/mL (Zuckerman, 2008)

**Steady State:**
- Occurred within 2 weeks following oral once daily dosing of everolimus
- 5 days

**Monitoring:**
- For renal transplantation, monitor everolimus serum concentrations, especially in patients with hepatic impairment, with concomitant CYP3A4 inhibitors and inducers, and when cyclosporine formulations or doses are changed; monitor cyclosporine concentrations; monitor for proteinuria.

### Sirolimus

**Therapeutic range:**
- 4.5-14 ng/mL
  - (測定方式: CMIA)

**Steady State:**
- Initial dosing or dose change at least 3 days
- 2-3 days

**Monitoring:**
- **Lab Tests:**
  - sirolimus levels in all patients (especially in pediatric patients, patients ≥13 years of age weighing <40 kg, patients with hepatic impairment, or on concurrent potent inhibitors or inducers of CYP3A4 or P-gp, and/or if cyclosporine dosing is markedly reduced or discontinued), and when changing dosage forms of sirolimus.

### Tacrolimus

**Therapeutic range:**
- Not absolutely defined, dependent on organ transplanted, time after transplant, organ function and tacrolimus toxicity. (右側)

**Steady State:**
- Initial dosing or dose change at least 3 days
- 2-3 days

**Monitoring:**
- **Lab Tests:**
  - Heart: Typical whole blood trough concentrations:
    - Months 1-3: 10-20 ng/mL
    - Months ≥4: 5-15 ng/mL
  - Kidney transplant: Whole blood trough concentrations: In combination with azathioprine:
In combination with mycophenolate mofetil/IL-2 receptor antagonist (eg daclizumab): Months 1-2: 4-11 ng/mL.
3. Liver transplant: Whole blood trough concentrations: Months 1-12: 5-20 ng/mL.
4. Prevention of graft-versus-host disease (unlabeled use): 10-20 ng/mL (Uberti, 1999) although some institutions use ≥5 ng/mL and an ≤15 ng/mL (Przepiorka, 1999; Yanik, 2000)

一般注意事項：
1. Cyclosporine、tacrolimus 及 sirolimus 以紫頭試管送檢，其他品項皆以紅頭試管送檢。檢體量：3 mL (新生兒採血不易可以小試管取血 1 mL)
2. Amikacin、sirolimus 與 everolimus 送至外院「聯合檢驗所」檢驗，欲先查詢結果，電話：(02)27049977
3. Digoxin、valproic acid、phenytoin 之血中濃度可急作監測。

(*)特殊注意事項：
1. Although AUC/MIC is the preferred pharmacokinetic-pharmacodynamic parameter used to determine clinical effectiveness, trough serum concentrations may be used as a surrogate marker for AUC and is recommended as the most accurate and practical method of vancomycin monitoring (Liu, 2011; Rybak, 2009).( UpToDate)
2. Valproic acid：Some laboratories may report >200 mcg/mL as a toxic threshold, although clinical toxicity can occur at lower concentrations.
3. Digoxin：Critical Values：Toxic: >1.2 ng/mL. The most common manifestations of suspected toxicity are nausea and vomiting, ventricular fibrillation, tachycardia, supraventricular arrhythmia, and second- or third-degree atrioventricular block. Panic value: >3.0 ng/mL.( LEXI-COMP’s);
   Panic level (adult) >2.4 ng/mL;Panic level (children) >3 ng/mL(Stat Ref.2012)
4. Critical Values >20 μg/mL;toxicity can take place at 15 μg/mL. Chronic seizures: 30-50 μg/mL, Acute toxicity seizures and malignant arrhythmias: >80 μg/mL.( LEXI-COMP’s)
5. Concentrations and ranges are dependent on and will vary with assay methodology (chromatographic or immunoassay); assay methods are not interchangeable. ( LEXI-COMP’s)

參考資料：
1. UpToDate 19.3, 2012
2. Micromedex 2, 2012
3. LEXI-COMP’s 2012, Lexi-Tox(toxicology)：Lab Tests and Diagnostic Procedures, THERAPEUTIC DRUG MONITORING