

# 18<sup>TH</sup> REPORT OF THE MALAYSIAN DIALYSIS & TRANSPLANT REGISTRY 2010

Edited by :

**Lim YN**

**Ong LM**

**Goh BL**

With contributions from :

**Ghazali A, Wong H S, Liu W J, Lee M L, Philip N J, Chee S S, Prasad M,  
Rozina G, Teo S M, Tan C C, Sunita B, Chew S M, Lee D G**



Malaysian Society of Nephrology



Association of Dialysis  
Medical Assistants and Nurses

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Suite 1604, Plaza Permata

6, Jalan Kampar

50400 Kuala Lumpur

Malaysia

Telephone. : (603) 4045 8636

Direct Fax : (603) 4042 7694

e-mail : [nrr@msn.org.my](mailto:nrr@msn.org.my)

Web site : <http://www.msn.org.my/nrr>

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# ABOUT THE MALAYSIAN DIALYSIS AND TRANSPLANT REGISTRY (MDTR).....

The Malaysia Dialysis and Transplant Registry (MDTR) collects information on patients with end stage renal disease (ESRD) on renal replacement therapy (RRT) in Malaysia.

## Objectives:

The objectives of the registry are as follows:

1. **Describe the natural history of ESRD.** The registry shall describe the characteristics of patients with ESRD, its management, and patient survival and quality of life outcomes with treatment; and shall describe variation thereof across different groups, healthcare sectors or geographic regions, and its secular trend over time in Malaysia.
2. **Determine effectiveness of treatments for ESRD.** The registry shall determine clinical effectiveness and cost effectiveness of treatments of ESRD in real-world clinical practices in Malaysia.
3. **Monitor safety and harm of products and services used in the treatment of ESRD.** The registry shall serve as an active surveillance system for the occurrence of unexpected or harmful events for products and services.
4. **Evaluating access to and quality of treatment services for ESRD.** The registry shall assess differences between providers or patient populations based on performance measures that compare treatments provided or outcomes achieved with “gold standards” (e.g., evidence-based guidelines) or comparative benchmarks for specific health outcomes (e.g., risk-adjusted survival rates). Such programs may be used to identify disparities in access to care, demonstrate opportunities for improvement, establish differentials for payment by third parties, or provide transparency through public reporting.
5. **To maintain the national renal transplant waiting list electronically – the eMOSS or electronic Malaysian Organ Sharing System.** The dialysis registry shall maintain and update patients on dialysis who do not have contraindications to kidney transplantation onto the national renal transplant waiting list according to published agreed criteria. This list is available on the web for ready access by the transplant physicians any time a deceased kidney becomes available.

## Registry design:

This is a multi-center, observational cohort study designed to evaluate the health outcomes of patients with ESRD undergoing treatment at participating clinical centres. Patient inclusion criterion is deliberately broad and shall include any patient with a confirmed diagnosis of ESRD.

There is no prescribed study visits. Patient shall attend the clinical site as and when required per the standard of care at the site. Required data shall be collected as they become available.

- A clinical site shall notify all new patients to the registry, and shall continue to do so until the termination of the registry. Patients shall be follow-up for life.
- Participation. Site shall notify the patients' treatment to the registry in a calendar year of its participation. A site shall similarly notify patients during each year of its participation in the registry.

## Registry study population:

The registry study population consists of male or female patients with ESRD to be recruited from participating sites in Malaysia. Participation in this study is voluntary. However, in accordance with the Private Health-care Facilities Act 1998 (AKTA 586), all dialysis health facility are required to submit data to the Malaysian Dialysis and Transplant Registry (MDTR).

All clinical centres or sites that satisfy the following selection criteria will be invited to participate:

1. This registry is opened to all clinical sites that provide RRT services for patients with ESRD in Malaysia.
2. Each site shall have a Principal Investigator who is also a licensed physician / Surgeon and a qualified professional experienced with ESRD management.
3. Each site shall appoint a Site Coordinator (SC). The SC is the person at the participating clinical site who is responsible for all aspects of registry management and data collection at site, and who will liaise with the Clinical Registry Manager (CRM) and Clinical Registry Assistant (CRA) at the Registry Coordinating Centre (RCC).
4. Each site shall accept responsibility for data collection, as well as for ensuring proper record keeping and registry document filing.
5. Each site shall agree to comply with the registry procedures and shall be willing to be subjected to ongoing review of data by CRM or CRA or other representative of MDTR. This may include one or more site visits by prior arrangement

*Patient eligibility criteria:*

- All new patients with ESRD undergoing treatment at a participating clinical site are eligible for entry into the registry.
- In addition, a site may opt to enter existing patients on follow-up at the site into the registry.

**Registry data:**

The data elements to be collected by the registry shall be relevant and reliable with modest burden to sites, shall comply with existing data standard where this exists, shall be compatible with established data set used by other existing registries, and shall employ standard terminology (dictionary) where available.

*Two datasets are defined:*

- Core dataset: These are data elements that are needed to address the key questions for which the registry was created.
- Non-core dataset: these are speculative data elements included to provide an opportunity to generate hypotheses or to explore other subsidiary questions not of primary interest to the registry.

The data domains and related specific data elements to be collected by this registry is tabulated below:

A	Identifier	Name, NRIC number, Other identifying document numbers, Address, Contact numbers
B	Demographics	Age, Sex, Ethnicity, Educational attainment, Occupation, Household Income group, Weight & Height, Use of tobacco, Funding for Treatment
C	Medical history	Medical history/ comorbidities, Family history
D	ESRD diagnosis	Date of first diagnosis, Date re-entering each RRT.
E	Laboratory investigations	Date & time of tests, Blood chemistry, Hematology, Serology
F	Treatment	Modalities of RRT- haemodialysis, peritoneal dialysis; treatment of other uraemic complications; kidney transplantation
G	Outcomes	Patient survival; death, date of death, cause of death Quality of Life/ Work rehabilitation status
H	Economics	Source of funding for dialysis treatment, and immunosuppressive drug treatment for transplantation
J	Healthcare provider characteristics	Sector providing dialysis treatment, (private, public or NGO),

# PARTICIPATING HAEMODIALYSIS CENTRES 2010

## Johor Darul Takzim

1. Batu Pahat Hospital, HD Unit
2. Batu Pahat Rotary, HD Unit
3. BP Renal Care ( Rengit), HD Unit
4. BP Renal Care (Batu Pahat), HD Unit
5. BP Renal Care (Kluang), HD Unit
6. BP Renal Care (Segamat), HD Unit
7. BP Renal Care Simpang Renggam, HD Unit
8. BP Renalcare (Yong Peng), HD Unit
9. Che Eng Khor Centre, HD Unit
10. Hospital Pakar Sultanah Fatimah (Muar), HD Unit
11. JB Lions MAA-Medicare Charity Dialysis Centre (1), HD Unit
12. JB Lions MAA-Medicare Charity Dialysis Centre (2), HD Unit
13. JJ Lions Dialysis Centre, HD Unit
14. Johor Quarries Association Dialysis Centre, HD Unit
15. Johor Specialist Hospital, HD Unit
16. Kluang Hospital, HD Unit
17. Kota Tinggi Hospital, HD Unit
18. Mersing Hospital, HD Unit
19. Mersing Rotary Centre, HD Unit
20. Muar Dialysis, HD Unit
21. Muar Lions Renal Centre, HD Unit
22. Persatuan Membaiki Akhlak-Che Luan Khor\_NKF, HD Unit
23. Pertubuhan Hemodialisis Muhibbah Segamat (Labis), HD Unit
24. Pertubuhan Kebajikan Amitabha, HD Unit
25. Pontian Hospital, HD Unit
26. Pontian Rotary Haemodialysis Centre, HD Unit
27. Premier Renal Care, HD Unit
28. Prima Dialysis Kluang, HD Unit
29. Prima Dialysis Masai, HD Unit
30. Pusat Dialisis Nefro Utama (Johor Bahru), HD Unit
31. Pusat Dialisis Nefro Utama (Kota Tinggi), HD Unit
32. Pusat Dialisis Nefro Utama Pontian, HD Unit
33. Pusat Dialisis Perbadanan Islam (Johor Bahru), HD Unit
34. Pusat Dialisis Perbadanan Islam (Pontian), HD Unit
35. Pusat Dialisis Waqaf An-nur (Batu Pahat), HD Unit
36. Pusat Dialisis Waqaf An-nur (Kota Raya), HD Unit
37. Pusat Dialisis Waqaf An-nur (Pasir Gudang), HD Unit
38. Pusat Dialysis Makmur, HD Unit
39. Pusat Haemodialisis Suria (Tangkak), HD Unit
40. Pusat Haemodialisis Amal Lexin, HD Unit
41. Pusat Hemodialisis Ar-Raudhah, HD Unit
42. Pusat Hemodialisis Bandar Mas, HD Unit
43. Pusat Hemodialisis Darul Takzim (Batu Pahat), HD Unit
44. Pusat Hemodialisis Darul Takzim (Parit Raja), HD Unit
45. Pusat Hemodialisis Hidayah, HD Unit
46. Pusat Hemodialisis Iman, HD Unit
47. Pusat Hemodialisis MAIJ, HD Unit
48. Pusat Hemodialisis Mawar (Yong Peng) HD Unit
49. Pusat Hemodialisis Muar, HD Unit
50. Pusat Hemodialisis Rotary Kota Tinggi, HD Unit
51. Pusat Hemodialisis Rotary Kulai, HD Unit
52. Pusat Hemodialisis Sejahtera (Batu Pahat), HD Unit
53. Pusat Hemodialisis Sejahtera Muar, HD Unit
54. Pusat Hemodialisis Syifa (Bukit Gambir), HD Unit
55. Pusat Perubatan Perbadanan Islam (Segamat), HD Unit
56. Puteri Specialist Hospital, HD Unit
57. Segamat Hospital, HD Unit
58. Sinar Haemodialysis (Batu Pahat), HD Unit
59. Sultan Ismail Hospital (Paed), HD Unit
60. Sultan Ismail Hospital, HD Unit
61. Sultanah Aminah Hospital, HD Unit
62. Systemic Dialysis Centre (2), HD Unit
63. Systemic Dialysis Centre, HD Unit
64. Tangkak Hospital, HD Unit
65. Tangkak Lions Renal Centre, HD Unit

66. Temenggong Seri Maharaja Tun Ibrahim Hospital, HD Unit
67. The Rotary HD Centre (Johor Bahru), HD Unit
68. Yayasan Pembangunan Keluarga Johor-NKF, HD Unit
69. Yayasan Rotary Kluang, HD Unit
70. Zhi En Dialysis Centre, HD Unit

## Kedah Darul Aman

71. Asia Renal Care (Penang) Kulim, HD Unit
72. Baling Hospital, HD Unit
73. Buddhist Tzu Chi (Jitra), HD Unit
74. Buddhist Tzu Chi Dialysis Centre (Kedah), HD Unit
75. Caring Dialysis (Gurun), HD Unit
76. Kuala Nerang Hospital, HD Unit
77. Kulim Haemodialysis (CS Tan), HD Unit
78. Kulim Hospital, HD Unit
79. Langkawi Hospital, HD Unit
80. Metro Specialist Hospital, HD Unit
81. Northern Dialysis Centre, HD Unit
82. Pantai Hospital Sungai Petani, HD Unit
83. Pertubuhan Bakti Fo En Bandar Kulim, HD Unit
84. Pusat Dialisis Albukhary, HD Unit
85. Pusat Dialisis K K Tan (Sg Petani), HD Unit
86. Pusat Haemodialisis Dr. Ismail, HD Unit
87. Pusat Hemodialisis Beng Siew, HD Unit
88. Pusat Hemodialisis Mergong, HD Unit
89. Pusat Hemodialisis S P, HD Unit
90. Pusat Hemodialisis Seroja (Kulim 1), HD Unit
91. Pusat Hemodialisis Seroja (Kulim 2), HD Unit
92. Pusat Hemodialisis Syifa (Pendang), HD Unit
93. Pusat Kesihatan Jitra, HD Unit
94. Pusat Pakar Dialisis Traktif (Jitra), HD Unit
95. Pusat Rawatan Hemodialisis Yayasan Enkay & Sultanah Bahiyah, HD Unit
96. Putra Haemodialysis Centre, HD Unit
97. Putra Medical Centre, HD Unit
98. Rawatan Dialisis Amal Lion\_NKF, HD Unit
99. Renal Care (Kedah), HD Unit
100. Sik Hospital, HD Unit
101. Sultan Abdul Halim Hospital, HD Unit
102. Sultanah Bahiyah Hospital, HD Unit
103. Superkids Trinity-NKF Dialysis Centre, HD Unit
104. Yan Hospital, HD Unit
105. Zaharah Dialysis Center, HD Unit

## Kelantan Darul Naim

106. Gua Musang Hospital, HD Unit
107. Hudaz Dialysis Centre, HD Unit
108. Jeli Hospital, HD Unit
109. KB Rotary-MAA Charity Dialysis, HD Unit
110. Keluarga Bahagia Haemodialisis, HD Unit
111. Kuala Krai Hospital, HD Unit
112. Machang Hospital, HD Unit
113. Nephrolife Haemodialysis Centre, HD Unit
114. Pakar Perdana Hospital, HD Unit
115. Pasir Mas Hospital, HD Unit
116. Pusat Dialisis Yayasan Buah Pinggang Kebangsaan (Kota Bharu), HD Unit
117. Pusat Hemodialisis Berkat Seroja (Machang), HD Unit
118. Pusat Hemodialisis Syifaq, HD Unit
119. Pusat Perubatan Tentera (Kota Bharu), HD Unit
120. Pusat Rawatan Dialisis Islah (Kota Bharu), HD Unit
121. Raja Perempuan Zainab II Hospital, HD Unit
122. Renal-Link (Kelantan), HD Unit
123. Tanah Merah Hospital, HD Unit
124. Tengku Anis Hospital, HD Unit
125. Tumpat Hospital, HD Unit
126. Universiti Sains Malaysia Hospital, HD Unit



**Negeri Melaka**

127. 94 Hospital Angkatan Tentera (Terendak), HD Unit
128. Alor Gajah Dialysis Centre, HD Unit
129. Alor Gajah Hospital, HD Unit
130. Amitabha Centre (Melaka), HD Unit
131. Damai Medical & Heart Clinic, HD Unit
132. Mahkota Medical Centre, HD Unit
133. Melaka Hospital, HD Unit
134. Pantai Air Keroh Hospital, HD Unit
135. Pertubuhan Kebajikan Hemodialisis Hospital Pakar Putra Melaka, HD Unit
136. Pusat Dialisis Giat Kurnia (Masjid Tanah), HD Unit
137. Pusat Dialisis Giat Kurnia (Merlimau), HD Unit
138. Pusat Dialisis Nephrocare (Bukit Piatu), HD Unit
139. Pusat Dialysis Comfort, HD Unit
140. Pusat Haemodialisis Suria (Jasin), HD Unit
141. Pusat HD SJAM Bacang Melaka, HD Unit
142. Pusat Hemodialisis Aman, HD Unit
143. Pusat Hemodialisis Impian, HD Unit
144. Pusat Hemodialisis Krisda, HD Unit
145. Pusat Hemodialisis SJAM Pulau Sebang, HD Unit
146. Pusat Hemodialisis Yayasan Toh Puan Zurina, HD Unit
147. Pusat Rawatan Dialisis Nefro Utama (Masjid Tanah), HD Unit
148. Sinar Hemodialisis, HD Unit
149. Tenang Haemodialysis Centre, HD Unit
150. Tenang Haemodialysis Jasin, HD Unit

**Negeri Sembilan Darul Khusus**

151. D'kasih Hemodialysis
152. Giat Kurnia Dialysis Centre (Nilai)
153. Haemodialysis Mawar Gemas
154. Jelebu Hospital
155. Port Dickson Hospital
156. Pusat Dialisis Suria (Tampin)
157. Pusat Haemodialisis Renalife
158. Pusat Haemodialisis Suria (Senawang)
159. Pusat Hemodialisis Berkat Seroja (Kuala Pilah)
160. Pusat Hemodialisis Gemencheh
161. Pusat Hemodialisis Mawar (Mantin)
162. Pusat Hemodialisis Mawar N. Sembilan (Bahau)
163. Pusat Hemodialisis Mawar N. Sembilan (Lukut)
164. Pusat Hemodialisis Mawar N. Sembilan (Rantau)
165. Pusat Hemodialisis Mawar N. Sembilan (Seremban)
166. Pusat Hemodialisis Mutiara
167. Pusat Pakar Dialisis Traktif (Kuala Pilah)
168. Pusat Waqaf An-nur (Senawang)
169. Seremban Specialist Hospital
170. Tampin Hospital
171. Tuanku Ampuan Najihah Hospital
172. Tuanku Ja'afar Hospital (Paed)
173. Tuanku Ja'afar Hospital

**Pahang Darul Makmur**

174. Bentong Hospital
175. Caring Dialysis (Jerantut)
176. Fitra Med
177. Hospital Sultanah Hajjah Kalsom
178. Jengka Hospital
179. Jerantut Hospital
180. Kuala Lipis Hospital
181. Kuantan Clinical Diagnostic Centre
182. Kuantan Medical Centres
183. Kuantan Specialist Centre
184. Lipis Dialysis Centre

185. MAA-Medicare Charity (Mentakab)
186. Mentakab Haemodialysis Unit
187. Muadzam Shah Hospital
188. Pahang Buddhist Association
189. Pekan Hospital
190. Pusat Hemodialisis Islam Makmur
191. Pusat Hemodialisis Jerantut
192. Pusat Hemodialisis Suria (Bentong)
193. Pusat Rawatan Dialisis Fitra
194. Pusat Rawatan Dialisis Fitra
195. Pusat Rawatan Dialisis Tun Abdul Razak-NKF Kuantan
196. Pusat Rawatan Hemodialisis Sang Riang Bera
197. Raub Hospital
198. SJAM-KPS Haemodialysis Centre 9 (Raub)
199. Sultan Haji Ahmad Shah Hospital
200. Suria Dialysis Centre (Temerloh)
201. Tengku Ampuan Afzan Hospital (Paed)
202. Tengku Ampuan Afzan Hospital

**Perak Darul Ridzuan**

203. 96 Hospital Angkatan Tentera (Lumut)
204. Batu Gajah Hospital
205. Berchaam Dialysis Centre
206. C. S. Loo Kidney & Medical Specialist Centre
207. Caring Dialysis Centre (Batu Gajah)
208. Caring Dialysis Centre (Sg Siput)
209. Caring Dialysis Centre (Teluk Intan)
210. Changkat Melintang Hospital
211. Fatimah Hospital
212. Gerik Hospital
213. Hope Haemodialysis Society Ipoh
214. Kampar Hospital
215. Kuala Kangsar Hospital
216. MAA-Medicare Charity (Teluk Intan)
217. MB Star Rawatan Dialisis
218. Nur Dialysis Centre
219. Parit Buntar Hospital
220. Persatuan Amal Chin Malaysia Barat
221. Pertubuhan Perkhidmatan Haemodialisis Ar-Ridzuan
222. Pertubuhan Perkhidmatan Hemodialisis AIXIN Kerian
223. PMA Chan Meng Khor-MAA Medicare Charity Dialysis Centre
224. Pulau Pangkor Hospital
225. Pusat Dialisis Darul Iltizam (Slim River)
226. Pusat Dialisis Darul Iltizam (Taiping)
227. Pusat Dialisis Ehsan Perak (Parit Buntar)
228. Pusat Dialisis Intan
229. Pusat Dialisis Kuala Kangsar
230. Pusat Dialisis Makmur
231. Pusat Dialisis Mutiara
232. Pusat Dialisis Penawar Permai
233. Pusat Dialisis Setia (Ipoh)
234. Pusat Dialisis Taiping (Kamunting)
235. Pusat Dialisis Taiping (Kuala Kangsar)
236. Pusat Dialisis Taiping (Parit Buntar)
237. Pusat Dialisis Taiping
238. Pusat Dialisis Setia
239. Pusat Hemodialisis Darul Iltizam (Ipoh)
240. Pusat Hemodialisis Kampar Yayasan Nanyang-SJAM
241. Pusat Hemodialisis Manjung
242. Pusat Hemodialisis Nyata Segar
243. Pusat Rawatan Dialisis Wan Nong
244. Putri Haemodialysis Centre (Ipoh)
245. Raja Permaisuri Bainun Hospital (Home)



# PARTICIPATING HAEMODIALYSIS CENTRES 2010 (CON'T)



- 246. Raja Permaisuri Bainun Hospital
- 247. Renal Care (Ipoh Specialist)
- 248. Selama Hospital
- 249. Seri Manjung Hospital
- 250. Sg Siput Hospital
- 251. SJ Dialysis Centre (Bidor)
- 252. SJ Dialysis Centre (Ipoh)
- 253. SJAM\_KPS 15 (Ipoh)
- 254. Slim River Hospital (Tanjong Malim)
- 255. Taiping Hospital
- 256. Tapah Hospital
- 257. Teluk Intan Hospital
- 258. Woh Peng Cheang Seah
- 259. Yayasan Akhlak-NKF Taiping
- 260. Yayasan Dialysis Pendidikan Akhlak Perak-NKF Ipoh

## Perlis Indera Kayangan

- 261. Tuanku Fauziah Hospital
- 262. Tuanku Syed Putra\_NKF Kangar Haemodialysis Centre

## Penang

- 263. Alkom Bakti Dialysis
- 264. AMD Rotary (Penang)
- 265. Asia Renal Care (Penang) BM
- 266. Balik Pulau Hospital
- 267. BBA (Butterworth) Dialysis Centre
- 268. Buddhist Tzu Chi Dialysis Centre (Butterworth)
- 269. Buddhist Tzu Chi HD Centre (Penang)
- 270. Bukit Mertajam Hospital
- 271. Fo Yi NKF Dialysis Centre (1)
- 272. Fo Yi NKF Dialysis Centre (2)
- 273. Gleneagles Medical Centre
- 274. Happy Kid Nees Dialysis Centre
- 275. Island Hospital
- 276. K K Tan Specialist (BM)
- 277. Kepala Batas Hospital
- 278. KPJ Penang Specialist Hospital
- 279. Lam Wah Ee Hospital
- 280. Lim Boon Sho Dialysis Centre
- 281. Loh Guan Lye Specialist Centre
- 282. MAA-Medicare Charity (Butterworth)
- 283. Muhibah Renal Care
- 284. NEPH Sdn Bhd
- 285. Nucare Dialysis Centre
- 286. Penang Adventist Hospital
- 287. Penang Caring Dialysis Society
- 288. Persatuan Kebajikan Haemodialysis St Anne BM
- 289. Pertubuhan Dialysis Rotary-Satu Hati
- 290. Pertubuhan Hemodialisis SPS
- 291. Province Wellesley Renal Medifund
- 292. Pulau Pinang Hospital (Home)
- 293. Pulau Pinang Hospital (Paed)
- 294. Pulau Pinang Hospital
- 295. Pusat Dialisis BMC
- 296. Pusat Dialisis Ehsan Perak (Pedar)
- 297. Pusat Haemodialisis Zakat (Jawi)
- 298. Pusat Hemodialisis Sinona
- 299. Pusat Hemodialisis Zakat (Balik Pulau)
- 300. Pusat Hemodialisis Zakat (Bukit Mertajam)
- 301. Pusat Hemodialisis Zakat (Butterworth)
- 302. Pusat Hemodialisis Zakat (Kepala Batas)
- 303. Pusat Hemodialisis Zakat (P. Pinang)
- 304. Pusat Hemodialisis Bestari

- 305. Pusat Rawatan Dialisis Lions-NKF (Penang)
- 306. PWRM (BM) Dialysis Centre
- 307. Renal Link (Penang)
- 308. Seberang Jaya Hospital (Butterworth)
- 309. Seberang Perai (Bagan)
- 310. SJ Dialysis Centre (Seberang Jaya)
- 311. Sungai Bakap Hospital
- 312. The Penang Community HD Society
- 313. TSC Renal Care

## Sabah

- 314. BBA (Tawau) Dialysis Centre
- 315. Beaufort Hospital
- 316. Beluran Hospital
- 317. Caring Dialysis Centre (Sandakan)
- 318. Caring Dialysis Centre Kota Kinabalu
- 319. Duchess of Kent Hospital
- 320. Keningau Hospital
- 321. Kota Belud Hospital
- 322. Kota Kinabatangan Hospital
- 323. Kota Marudu Hospital
- 324. Kudat Hospital
- 325. Labuan Hospital
- 326. Lahad Datu Hospital
- 327. Likas Hospital (Paed)
- 328. Likas Hospital
- 329. MAA-Medicare Charity (Kota Kinabalu)
- 330. Nobel Dialysis Centre
- 331. Papar Hospital
- 332. Persatuan Buah Pinggang Sabah
- 333. Persatuan Hemodialysis Kinabalu Sabah
- 334. Pusat Rawatan Dialisis MUIS-NKF
- 335. Queen Elizabeth Hospital
- 336. Ranau Hospital
- 337. Rotary Tawau Tanjung
- 338. Sabah Medical Centre
- 339. Sandakan Kidney Society
- 340. Semporna Hospital
- 341. Sipitang Hospital
- 342. Tambunan Hospital
- 343. Tawau Hospital
- 344. Tenom Hospital

## Sarawak

- 345. 801 Rumah Sakit Angkatan Tentera (Kuching)
- 346. Bau Hospital
- 347. Betong Hospital
- 348. Bintulu Hospital
- 349. CHKMUS-MAA Medicare Charity
- 350. Hospital Daerah Daro
- 351. Kanowit Hospital
- 352. Kapit Hospital
- 353. KAS-Rotary-NKF
- 354. Kuching Specialist Hospital
- 355. Lawas Hospital
- 356. Limbang Hospital
- 357. Lundu Hospital
- 358. Marudi Hospital
- 359. Miri Hospital
- 360. Miri Red Crescent Dialysis Centre
- 361. Mukah Hospital
- 362. Normah Medical Specialist Centre
- 363. Pusat Dialisis Cahaya

364. Pusat Dialisis Waqaf An-Nur (Sarawak)  
 365. Rejang Medical Centre  
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 371. Serian Hospital  
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 377. Sri Aman Hospital  
 378. Timberland Medical Centre
- Selangor Darul Ehsan**
379. 819 Rumah Sakit Angkatan Tentera  
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 381. Apex Club of Klang-NKF Charity Dialysis Centre  
 382. Assunta Hospital  
 383. Bakti-NKF Dialysis Centre  
 384. Bangi Dialysis Centre  
 385. Banting Hospital  
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 387. Berjaya NKF Dialysis Centre  
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 389. Caring Dialysis Centre (Sabak Bernam)  
 390. Caring Dialysis Centre (Sg. Besar)  
 391. Caring Dialysis Centre Andalas (Klang)  
 392. Damansara Specialist Hospital  
 393. EAM Dialysis Centre  
 394. Haemodialysis Association Klang  
 395. Harmoni Dialysis (Damansara)  
 396. Harmoni Dialysis (Kajang)  
 397. Healthcare Dialysis Centre  
 398. Hemodialisis Yayasan Veteran ATM (S Kembangan)  
 399. Jerteh Dialysis Centre  
 400. Kajang Hospital  
 401. Kelana Jaya Medical Centre  
 402. KPJ Ampang Puteri Specialist Hospital  
 403. KPJ Kajang Specialist Hospital  
 404. KPJ Selangor Specialis Hospital  
 405. Kuala Kubu Bharu Hospital  
 406. MAA-Medicare Charity (Kajang)  
 407. Persatuan Dialisis Kurnia PJ  
 408. Ping Rong-NKF  
 409. PNSB Dialysis Centre  
 410. Pusat Dialisis Aiman (Shah Alam)  
 411. Pusat Dialisis An'nur  
 412. Pusat Dialisis As Sofi  
 413. Pusat Dialisis LZS (Kapar)  
 414. Pusat Dialisis LZS (Sg. Besar)  
 415. Pusat Dialisis LZS (Shah Alam)  
 416. Pusat Dialisis MAIS Taman Melawati  
 417. Pusat Dialisis MAIS  
 418. Pusat Dialisis Mesra (Kuala Selangor)  
 419. Pusat Dialisis NKF-Rotary Damansara  
 420. Pusat Dialisis Pakar Medi-Nefro  
 421. Pusat Dialisis Putra Jaya (Kajang)  
 422. Pusat Dialisis Sijangkang  
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 450. Renal Care Dialysis Services  
 451. S.P. Menon Dialysis Centre (Klang)  
 452. S.P. Menon Dialysis Centre (Petaling Jaya)  
 453. Sayang Dialysis Selayang  
 454. Selayang Hospital  
 455. Serdang Hospital  
 456. Sime Darby Medical Centre Subang Jaya  
 457. SJAM-KPS Haemodialysis Centre 1 (Raja Muda Musa)  
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 464. SJAM-KPS Pusat Hemodialisis Tasik Puteri  
 465. Smartcare Dialysis Centre (Subang Jaya)  
 466. Sri Kota Medical Centre  
 467. Sungai Buloh Hospital  
 468. Sunway Medical Centre (2)  
 469. Sunway Medical Centre  
 470. Suriya Dialysis Centre  
 471. Syukur Elit  
 472. Tanjung Karang Hospital  
 473. Tengku Ampuan Jemaah Hospital  
 474. Tengku Ampuan Rahimah Hospital  
 475. Tulips Dialysis Centre  
 476. Universiti Kebangsaan Malaysia Bangi  
 477. Yayasan Kebajikan SSL Puchong  
 478. Yayasan Kebajikan SSL (Petaling Jaya)

## Terengganu Darul Iman

- 479. Besut Hospital
- 480. Dungun Hospital
- 481. Hulu Terengganu Hospital
- 482. Kemaman Hospital
- 483. Pusat Dialisis MAIDAM
- 484. Pusat Dialisis Nuraeen
- 485. Pusat Dialisis Terengganu/NKF
- 486. Pusat Hemodialisis Nabilah
- 487. Pusat Pakar Dialisis Traktif (Besut)
- 488. Pusat Rawatan Dialisis Islah (Kuala Terengganu)
- 489. Sultanah Nur Zahirah Hospital
- 490. YKN Dialisis (Terengganu)

## Wilayah Persekutuan Kuala Lumpur

- 491. Aiman Dialysis Centre
- 492. Al-Islam Specialist Hospital
- 493. Charis-NKF Dialysis Centre
- 494. Cheras Dialysis Centre
- 495. Hospital Angkatan Tentera Tuanku Mizan
- 496. Kuala Lumpur Hospital (Home)
- 497. Kuala Lumpur Hospital (Paed.)
- 498. Kuala Lumpur Hospital (Unit 1)
- 499. Kuala Lumpur Hospital (Unit 3)
- 500. Kuala Lumpur Hospital (Unit 4)
- 501. Kuala Lumpur Lions Renal Centre
- 502. MAA-Medicare Charity (Cheras)
- 503. MAA-Medicare Charity (Kuala Lumpur)
- 504. National Kidney Foundation Dialysis Centre (KL)
- 505. Pantai ARC Dialysis Services
- 506. Pantai Hospital Ampang
- 507. Poliklinik Komuniti Tanglin
- 508. Prince Court Medical Centre

- 509. Pusat Dialisis Falah
- 510. Pusat Dialisis Nefro Utama (Bangsar)
- 511. Pusat Dialisis Pusat Punggutan Zakat (Kuala Lumpur)
- 512. Pusat Dialysis Sentral
- 513. Pusat Hemodialisis Dato' Lee Kok Chee
- 514. Pusat Hemodialisis Desa Aman Puri
- 515. Pusat Hemodialisis Harmoni (Cheras)
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- 517. Pusat Hemodialisis Mawar N. Sembilan (Seputih)
- 518. Pusat Hemodialisis PMKL
- 519. Pusat Hemodialisis PUSRAWI
- 520. Pusat Hemodialisis Waz Lian
- 521. Pusat Hemodialisis Yayasan Felda
- 522. Pusat Hemodialisis Medipro Alliance
- 523. Pusat Pakar Tawakal
- 524. Pusat Perubatan Universiti Kebangsaan Malaysia
- 525. Pusat Rawatan Dialisis Fungates Superflow-NKF
- 526. Pusat Rawatan Dialisis Good Health-NKF (Kg Pandan)
- 527. Pusat Rawatan Dialisis Islah (KL)
- 528. Pusat Rawatan Dialisis Nefro Utama (Setapak)
- 529. Renal Dialysis Centre
- 530. Rotary Damansara-NKF Dialysis
- 531. S.P. Menon Dialysis Centre (Kuala Lumpur)
- 532. Sayang Dialysis Cawangan Wangsa Maju
- 533. Sentosa Medical Centre
- 534. Smartcare Dialysis Clinic (Cheras)
- 535. The Kidney Dialysis Centre (1)
- 536. The Kidney Dialysis Centre (2)
- 537. The Nayang-NKF Dialysis Centre
- 538. Tung Shin Hospital & Yayasan Nanyang Press
- 539. Tung Shin Hospital
- 540. University Malaya Medical Centre
- 541. University Malaya Specialist Centre
- 542. YKN Dialisis (Kuala Lumpur)

**Johor Darul Takzim**

1. BP Renal Care (Batu Pahat)
2. BP Renal Care (Segamat)
3. Hospital Pakar Sultanah Fatimah (Muar)
4. Puteri Specialist Hospital
5. Sultan Ismail Hospital (Paed)
6. Sultanah Aminah Hospital

**Kedah Darul Aman**

7. Sultanah Bahiyah Hospital

**Kelantan Darul Naim**

8. Raja Perempuan Zainab II Hospital
9. Universiti Sains Malaysia Hospital

**Negeri Melaka**

10. Damai Medical & Heart Clinic
11. Melaka Hospital

**Negeri Sembilan Darul Khusus**

12. Tuanku Ja'afar Hospital (Paed)
13. Tuanku Ja'afar Hospital

**Pahang Darul Makmur**

14. Tengku Ampuan Afzan Hospital (Paed)
15. Tengku Ampuan Afzan Hospital

**Perak Darul Ridzuan**

16. 96 Hospital Angkatan Tentera (Lumut)
17. Raja Permaisuri Bainun Hospital
18. Renal Care (Ipoh Specialist)

**Penang**

19. Pulau Pinang Hospital (Paed)
20. Pulau Pinang Hospital

**Sabah**

21. Duchess of Kent Hospital
22. Queen Elizabeth Hospital
23. Sabah Medical Centre

**Sarawak**

24. Normah Medical Specialist Centre
25. Sarawak General Hospital

**Selangor Darul Ehsan**

26. Selayang Hospital (Paed)
27. Selayang Hospital
28. Serdang Hospital
29. Sri Kota Medical Centre
30. Tengku Ampuan Rahimah Hospital

**Terengganu Darul Iman**

31. Sultanah Nur Zahirah Hospital

**Wilayah Persekutuan Kuala Lumpur**

32. Kuala Lumpur Hospital (Paed.)
33. Kuala Lumpur Hospital
34. Pusat Perubatan Universiti Kebangsaan Malaysia
35. University Malaya Medical Centre

# PARTICIPATING TRANSPLANT FOLLOW-UP CENTRES 2010

## **Johor Darul Takzim**

1. Batu Pahat Hospital
2. Kluang Hospital
3. Mersing Hospital
4. Pakar Sultanah Fatimah Muar Hospital
5. Pontian Hospital
6. Segamat Hospital
7. Sultan Ismail Hospital (Paed)
8. Sultan Ismail Pandan Hospital
9. Sultanah Aminah Hospital

## **Kedah Darul Aman**

10. Sultanah Bahiyah Hospital

## **Kelantan Darul Naim**

11. Raja Perempuan Zainab II Hospital
12. Universiti Sains Malaysia Hospital

## **Negeri Melaka**

13. Mahkota Medical Centre
14. Melaka Hospital

## **Negeri Sembilan Darul Khusus**

15. Tuanku Ja'afar Hospital

Pahang Darul Makmur

16. Tg. Ampuan Afzan Hospital

## **Perak Darul Ridzuan**

17. Raja Permaisuri Bainun Hospital
18. Renal Care (Ipoh Specialist)
19. Taiping Hospital

## **Penang**

20. Pulau Pinang Hospital

## **Sabah**

21. Duchess of Kent Hospital
22. Klinik Dr Choo & Liew
23. Labuan Hospital
24. Queen Elizabeth Hospital
25. Sabah Medical Centre
26. Tawau Hospital

## **Sarawak**

27. Bintulu Hospital
28. Miri Hospital
29. Sarawak General Hospital
30. Sibul Hospital
31. Timberland Medical Centre

## **Selangor Darul Ehsan**

32. Assunta Hospital
33. KPJ Ampang Puteri Specialist Hospital
34. Selayang Hospital
35. Serdang Hospital
36. Sime Darby Medical Centre Subang Jaya
37. Sri Kota Medical Centre
38. Tan Medical Renal Clinic
39. Tg. Ampuan Rahimah Hospital

## **Terengganu Darul Iman**

40. Kemaman Hospital
41. Sultanah Nur Zahirah Hospital

## **Wilayah Persekutuan Kuala Lumpur**

42. Fan Medical Renal Clinic
43. Kuala Lumpur Hospital (Paed)
44. Kuala Lumpur Hospital
45. Prince Court Medical Centre
46. Pusat Perubatan Universiti Kebangsaan Malaysia
47. University Malaya Medical Centre

# CONTRIBUTING AUTHORS

CHAPTER TITLE	AUTHORS	INSTITUTIONS
1 ALL RENAL REPLACEMENT THERAPY IN MALAYSIA	Lim Yam Ngo	Kuala Lumpur Hospital
	Ghazali B Ahmad	Kuala Lumpur Hospital
	Lee Day Guat	National Renal Registry
2 DIALYSIS IN MALAYSIA	Lim Yam Ngo	Kuala Lumpur Hospital
	Ghazali B Ahmad	Kuala Lumpur Hospital
	Tan Chwee Choon	Tengku Ampuan Rahimah Hospital
	Lee Day Guat	National Renal Registry
3 DEATH AND SURVIVAL ON DIALYSIS	Wong Hin Seng	Selayang Hospital
	Ong Loke Meng	Penang Hospital
4 QOL AND REHABILITATION OUTCOMES ON DIALYSIS PATIENTS IN MALAYSIA	Liu Wen Jiun	Sultanah Aminah Hospital
	Chew Thian Fook	Seremban Specialist Hospital
	Christopher Lim Thiam Seong	University Putra Malaysia
	Zaki Morad B Mohd Zaher	KPJ Kajang Specialist Hospital
5 PAEDIATRIC RENAL REPLACEMENT THERAPY	Lee Ming Lee	Tuanku Ja'afar Hospital
	Lim Yam Ngo	Kuala Lumpur Hospital
	Lynster Liaw Chiew Tung	Penang Hospital
	Susan Pee	Sultan Ismail Hospital
	Wan Jazilah Wan Ismail	Selayang Hospital
6 MANAGEMENT OF ANAEMIA IN DIALYSIS PATIENTS	Philip N. Jeremiah	KPJ Ampang Puteri Specialist Hospital
	Bee Boon Cheak	Selayang Hospital
	Ghazali B Ahmad	Kuala Lumpur Hospital
	Lim Soo Kun	University Malaya Specialist Centre
	Zawawi B Nordin	Sultanah Nur Zahirah Hospital
7 NUTRITIONAL STATUS ON DIALYSIS	Winnie Chee Siew Swee	International Medical University
	Abdul Halim B Abd Gafor	Pusat Perubatan Universiti Kebangsaan Malaysia
	Ahmad Fauzi B Abd Rahman	Puteri Specialist Hospital
	Koh Keng Hee	Sarawak General Hospital
	Tilakavati Karupaiah	Faculty of Allied Health Sciences University Kebangsaan Malaysia
8 BLOOD PRESSURE CONTROL AND DYSLIPIDAEMIA	S. Prasad Menon	Sime Darby Medical Centre Subang Jaya
	Hooi Lai Seong	Sultanah Aminah Hospital
	Lee Wan Tin	Sime Darby Medical Centre Subang Jaya
	Sunita Bavanandan	Kuala Lumpur Hospital
9 CHRONIC KIDNEY DISEASE - MINERAL AND BONE DISORDERS	Rozina Bt Ghazalli	Pulau Pinang Hospital
	Ching Chen Hua	Sultanah Bahiyah Hospital
	Fan Kin Sing	Gleneagles Intan Medical Centre
	Liew Yew Fong	Pulau Pinang Hospital
10 HEPATITIS ON DIALYSIS	Teo Sue Mei	Putri Haemodialysis Centre (Ipoh)
	Chow Yok Wai	Pantai Air Keroh Hospital
	Clare Tan Hui Hong	Sarawak General Hospital
	T. Thiruventhiran	Sunway Medical Centre
11 HAEMODIALYSIS PRACTICES	Tan Chwee Choon	Tengku Ampuan Rahimah Hospital
	Norleen Bt Zulkarnain Sim	Tengku Ampuan Rahimah Hospital
	Rafidah Abdullah	Selayang Hospital
	Shahnaz Shah Firdaus Khan	Tengku Ampuan Rahimah Hospital
12 PERITONEAL DIALYSIS PRACTICES	Sunita Bavanandan	Kuala Lumpur Hospital
	Anita Bhajan Manocha	Hospital Seberang Jaya
	Lily Mushahar	Tuanku Ja'afar Hospital
13 RENAL TRANSPLANTATION	Goh Bak Leong	Serdang Hospital
	Fan Kin Sing	Gleneagles Intan Medical Centre
	Rohan Malek Bin Dato' Dr. Johan	Selayang Hospital
	Rosnawati Yahya	Kuala Lumpur Hospital
	S. Prasad Menon	Sime Darby Medical Centre Subang Jaya
	Tan Si Yen	Prince Court Medical Centre
Wong Hin Seng	Selayang Hospital	

# FOREWORD

The time has come again for the much awaited latest report on dialysis and renal transplant program in Malaysia. What has now become a routine annual publication since 1993 has resulted in an assumed process that many among us has taken for granted until significant changes had taken place by circumstances and need.

In June 2010 , the pioneer and founder of the National Renal Registry (NRR), Dato' Dr. Zaki Morad Mohd Zaher had relinquished his post and ended his sterling service as the Chairman of the National Renal Registry , Malaysia and passed the baton to yours sincerely as approved by the Council of the Malaysian Society of Nephrology, the main sponsor of NRR. In addition , the pioneer Chief Editor and the main driver of NRR from its inception, Dr. Lim Teck Onn had also decided to let NRR move on with newer and younger blood to take over.

To ensure continuity and further developments, NRR need to prepare `second liners' and recruit new professionals to shadow and eventually take over the management from existing ones. For this purpose, we have now included two highly capable and committed nephrologists to assist the Editor, Dr. Lim Yam Ngo in her work. Dr. Goh Bak Leong and Dr. Ong Loke Meng will now serve as deputy editors to ensure the continued success of NRR. I wish to place on record here the gratitude and indebtedness of the nephrology community in this country to both Dato' Dr. Zaki Morad and Dr. Lim Teck Onn for their immense and untiring contributions to NRR making it one of the most successful clinical registry in this country. The success of NRR has even obtained recognition from the Health Ministry, Brunei Darussalam which had signed a memorandum of understanding in February this year for NRR to assist the country to establish the Brunei Dialysis and Transplant Registry.

As we move forward , there remains several issues which need serious thoughts and input from various stakeholders and clients of this registry.

1. With as much voluntarism and charitable efforts contributed by many including the MSN Council, The NRR Advisory Committee, The Expert Committee members etc , NRR will not and cannot function or survive without adequate and assured funding to manage its administrative and publication needs. Some members of the healthcare industry had valued the importance of the works and reports of NRR thereby contributed significantly to assure the financial requirements of NRR are met with and adequately supported. While this formula had worked in many years of NRR's existence, it may not serve the NRR needs perpetually. The stakeholders and clients of NRR need to join hands to support this need for many years to come to ensure NRR viability .
2. Since 2006 , the submission of annual return and the need to notify NRR of any significant outcomes affecting CAPD , HD and renal transplant patients had become a part of the legislation under the Private Healthcare Facilities and Services Act which had been enforced since 2008. Notwithstanding this fact , it is regretted that some operators of the haemodialysis service in private and NGO HD units did not comply and failed to submit data accordingly. While this is seen and can be interpreted as transgressing the current act , no action has been taken so far by the regulatory authority to ensure full compliance of this need. The time has now come to tie the funding mechanism of dialysis treatment with the submission of the necessary data to NRR to ensure compliance.
3. While the number of the HD units continue to rise exponentially in the country it has now come to a point when our emphasis should be focused on fulfilling the quality dialysis needs rather than continuously pursue the quantity agenda as we now have haemodialysis units in almost all the breadth and length of the country. The quality elements should be carefully thought of in the future collection of dataset and analysis to inform the professionals , the public , the healthcare industry, the healthcare authority and the fund providers regarding the quality of the output and outcome delivered to patients on long term dialysis.
4. Additionally , there are obvious needs for serious efforts and program to promote and expand peritoneal dialysis option and renal transplant program as both suffer poor progress compared to haemodialysis. . The need to have an effective national program to prevent and detect early the occurrence of chronic kidney diseases cannot be overemphasized.

On behalf of the NRR Advisory Committee members , I wish to record a sincere appreciation to all the data contributors without which we have no data to report , The Chairman and the Council Members of the Malaysian Society of Nephrology for the continued support of NRR needs , the expert committee members for diligently studying the analysed datasets and coming out with the timely expert reports on voluntary basis, the fund sponsors particularly Roche, AIN Medicare, Baxter Healthcare and Fresenius Medical Care, The Ministry of Health and last but not least the untiring and highly dedicated NRR Managers led by Mdm Lee Day Guat.

**Datuk Dr. Ghazali Ahmad**  
Chairman  
National Renal Registry



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# REPORT SUMMARY

- The number of patients commencing dialysis more than doubled in 10 years from 2112 in 2001 to 4740 in 2009 and at 4521 in 2010 (preliminary data). The acceptance of new dialysis patients was 170 per million population (pmp) in 2009 and 160 pmp in 2010.
- The number of dialysis patients in Malaysia has tripled in 10 years from 7837 in 2001 to 21245 in 2009 and 22932 in 2010 (preliminary data). The prevalence of dialysis patients was 762 pmp in 2009 and pmp 812 in 2010.
- Transplant incident rate remained at 4 per million and prevalence at 63 pmp in 2009.
- Dialysis treatment rate for elderly patients ( $\geq 65$  years old) have continued to show rapid increase to 1007 pmp in 2009. 55% of new dialysis patients were at least 55 years old at the onset of dialysis.
- There is still great disparity in dialysis provision rate between the economically advantaged and disadvantaged states ranging from 75 pmp to 272 pmp.
- The number of dialysis centres for the whole of Malaysia increased from 230 (10 pmp) in 2001 to 618 (22 pmp) in 2010. The growth was largely contributed by increase in the number of haemodialysis(HD) centres. Private HD sector recorded the highest growth rate particularly in the more economically developed west coast states of Malaysian Peninsula. The peritoneal dialysis rate remained stable.
- The Ministry of Health (MOH) provided dialysis to 30% of patients, non-governmental organizations (NGO) 28% and the private sector 40% of all dialysis patients in 2010.
- 88% of new patients were accepted into centre haemodialysis program in 2009 and 2010.
- The government continued to be the largest provider of funding for dialysis. 57% of patients on dialysis were funded by the government, 10% by non-government organisations and 22% were self funded.
- The proportion of new ESRD patients with diabetes mellitus was 56% in 2010.
- The annual death rate for haemodialysis patients was 11.2% while chronic peritoneal dialysis patients had annual death rate of 16.6%.
- In 2010, cardiovascular disease remained the main cause of death accounting for 34% of all death. Death from infection has increased over the last 4 years and is now the second leading cause of accounting for 24% of all death.
- Survival on haemodialysis was better compared with peritoneal dialysis. The overall unadjusted 5 years and 10 years patient survival censored for change in modality was 57% and 48% respectively on haemodialysis and 35% and 28% respectively on peritoneal dialysis.
- Patient variables that had significant impact on mortality were age, gender, primary renal disease, dialysis modality, BMI, diastolic blood pressure and the presence cardiovascular disease. The biochemical risk factors for mortality were serum albumin, serum cholesterol, haemoglobin, calcium, calcium phosphate product and phosphate.
- There was wide centre variation with regards to HD and PD patient survival.
- Quality of life was satisfactory in both HD and PD patients. Diabetes mellitus and older age were associated with lower median QoL index scores.
- Employment rate in HD patients was 69% and PD patients was 71%.
- The median dose of erythropoietin was 4000 units per week in both HD and PD patients.
- The proportion of patients receiving erythropoietin increased to 90% in HD patients and 78% in PD patients. There was an increasing trend on use of parenteral iron in HD patients (27% in 2010) and static in PD patients (12% in 2010). Requirement for blood transfusion remains the same (14% in HD patients and 16% in PD patients).
- The median usage of EPO among HD centres was 92%. There was a wide variations in the use of EPO among HD centres and blood transfusion rates, and hemoglobin levels among HD and PD centres.
- Mean serum albumin level in 2010 was 38.9 g/L in HD and 32.1 g/L in PD patients. There was a wide variations in proportion of patients with serum albumin  $\geq 40$ g/L among HD and PD centres.
- The mean body mass index in HD patients was 23.9 kg/m<sup>2</sup> and 24.5 kg/m<sup>2</sup> in PD patients was 24.5 in 2010. 35% of HD patients and 39% of PD patients were obese (BMI kg/m<sup>2</sup>)
- Predialysis systolic blood pressure (SBP) in haemodialysis patients remained suboptimally controlled with only 28% of haemodialysis patients achieving systolic BP  $< 140$  mmHg in 2010. Predialysis SBP was better controlled in PD patients in 2010, with 49% of PD patients having a predialysis SBP  $< 140$ mmHg.

- Control of total serum cholesterol and serum triglyceride levels were poorer in PD patients compared to haemodialysis in 2010. 77% of HD and 56% of PD patients achieved a total cholesterol < 5.3 mmol/L.
- Calcium carbonate remained the main phosphate binder for both HD patients (91%) and PD patients (88%) in 2010. Use of lanthanum (2%) continued to increase while aluminium based phosphate binder use decrease.
- Calcitriol remained the main vitamin D used in both HD (44%) and PD (38%) patients. Paricalcitol use remained small but has increased slightly among HD patients. The proportion of patients undergoing parathyroidectomy has shown a downward trend since 2006 in both HD and PD patients.
- A higher proportion of HD patients achieved normal range serum calcium level compared to PD patients (52% vs 37%) in 2010.
- PD patients had better phosphate control compared to HD patients (median level 1.5 vs 1.7mmol/l) and higher proportion of PD patients had normal range phosphate level compared to HD patients (53 vs 46%).
- PD patients had relatively higher level of iPTH compared to HD patients (median 97.2 ng/ml vs 163 ng/ml) and a higher proportion of HD patients had iPTH level <150 ng/ml (59%) compared to PD patients (48%).
- There was a wide centre variation among HD and PD populations in the prevalence of mineral bone disease.
- The prevalence of patients with Hepatitis B and C remained low. The prevalence of hepatitis C in HD patients continues to decline and was 7% in 2010.
- **Haemodialysis practices:**
  - The proportion of patients with native vascular access has declined from 96% in 2001 to 90% in 2010.
  - The proportion of patients with blood flow rate above 350mls increased from 4% in 2001 to 26% in 2010.
  - 98% of patients were on 3 dialysis sessions per week and 99% on 4 hour sessions
  - 80% of patients were using the dialysers made from synthetic membrane
  - 90% of patients re-use their dialyser. 19% of patients used their dialysers for at least 13 times.
  - The median prescribed Kt/V was 1.6 and delivered Kt/V was 1.4. 80% of patients had a prescribed Kt/V  $\geq$  1.3 while 79% achieve a delivered Kt/V  $\geq$  1.2. The median URR remained the same at 71.2% and 80% of patients achieved a URR  $\geq$  65% .
  - There was wide variation among HD centres in the proportion of patients achieving adequate blood flow and dose of dialysis.
  - Technique survival was better in HD compared to PD. 5 year and 9 year technique survival was 53% and 33% respectively for HD and 27% and 9 % respectively for PD.
  - Age and diabetes status had a significant impact on technique survival but the year of starting dialysis did not.
- **Chronic PD practices:**
  - In 2010, the total number of PD patients increased to 2360. The annual growth rate had slowed to 6.7%. Automated PD had grown gradually to 12.5%..
  - CAPD prescription has not changed much over the years.
  - The median delivered weekly Kt/V was 2.0 and 79% achieved target Kt/V of  $\geq$ 1.7
  - 73% of patients had either a low average or high average peritoneal membrane transport characteristic
  - The median PD technique survival time was 34 months
  - Increasing age, diabetes, peritonitis, male gender, cardiovascular disease, low serum albumin, low BMI, abnormal lipid profile, lower Hb, higher serum phosphate and assisted PD were associated with an increased risk for change of modality
  - The commonest reason for PD drop-out was peritonitis, followed by membrane failure and patient preference.
  - The median peritonitis rate among the PD centres was 35.3 episodes per patient-month in 2010. There was a wide inter-centre variation peritonitis rate among PD centres. Gram-positive organisms and gram-negative accounted for 29% of the peritonitis each. Staphylococcus aureus was the most common gram positive o organism while E. coli was the commonest gram negative organism.

- **Renal transplantation:**

- There was an 18% decline in number of transplantations to 102 in 2010 primarily due to the decline in commercial transplantation
- The transplantation rate was 4 pmp in 2010 and the prevalence had remained static at 65 pmp.
- Local kidney transplantation decreased to 55 in 2010 and accounted for 54% of transplantations. The proportion of commercial transplantation has gradually reduced a peak of 79% in 2004 to 34% in 2010. For the first time in 10 years there were more local transplant (66%) compared to overseas transplant (33%). The proportion of live donor transplantation reduced to 29% in 2010 and commercial live donation increased to 24%. There were 31 local cadaveric donation (37% of transplantation in 2010).
- The proportion of diabetic patients undergoing renal transplantation had been on a reducing trend from 18% in 2005 to 12% in 2010.
- Other characteristics remained unchanged. The mean age of transplantation was 40 years and 63% of recipients were males. The commonest primary renal disease was chronic glomerulonephritis followed by hypertension and diabetes mellitus.
- Although cyclosporine based regimes remained the most commonly used (61%), there has been a gradual reduction since 2006 coinciding with increasing trend in tacrolimus use (30% in 2010)
- Mycophenolate mofetil use increased to 59% while the use of Azathioprine declined to 27% in 2010.
- The rates of transplant death and graft loss have remained static for the past 10 years (1.8% and 2.5% respectively in 2010).
- The main causes of death have been infection (37%) and cardiovascular disease (185). Cancer death rate was 13% in 2009.
- Majority of graft loss were due to rejection (54%).
- Patient survival rates from 2001 to 2010 were 94%, 91%, 87% and 80% at year 1, 3, 5 and 10 respectively. The graft survival rate has been 93%, 87%, 81% and 68% at year 1, 3, 5 and 10 respectively.
- Patient and graft survival was the best among live donor recipients and worst in cadaveric graft recipients.

- **Paediatric RRT**

- The overall RRT incidence rate for paediatric patients less than 20 years old was 10 pmarp in 2009 and 8 pmarp in 2010 (preliminary data). 54% were placed on PD and 38% on HD.
- The number of transplants reduced to 8 (1 pmarp) in 2010 after an initial encouraging increase over the last 5 years.
- At the end of 2010, 633 children were on dialysis giving a prevalence of 62 pmarp. The prevalence of transplant in children was 18 pmarp.
- The dialysis treatment rate had leveled off over the last 10 years across the paediatric age spectrum. The treatment rate had remained consistently higher among the older age groups while the number of 0-4 year olds provided chronic dialysis treatment remained very low.
- Chronic PD was the first modality of dialysis in about two thirds of patients.
- Most children (84%) received their dialysis treatment from government centres and hence were government funded.
- The commonest cause of known ESRD was glomerulonephritis (23%). FSGS accounted for another 8% of patients.
- Renal transplantation had the best patient survival with 94% survival at 5 years and 89% at 10 years. HD patients consistently showed better survival compared to PD patients and this disparity becomes more marked when censored for change of dialysis modality.
- The commonest type of renal transplant done in children over the last 5 years was cadaveric transplant accounting for 55%.
- Graft survival for paediatric transplant was 90% at 1 year and 77% at 5 years.

# ABBREVIATIONS

BMI	Body Mass Index
BP	Blood pressure
CAPD	Continuous Ambulatory Peritoneal Dialysis
CCPD/APD	Continuous cycling peritoneal dialysis/automated peritoneal dialysis
CI	Concentration Index
CKD	Chronic kidney disease
CRA	Clinical Registry Assistant
CRA	Clinical Registry assistant
CRC	Clinical Research Centre
CRF	Case report form
CRM	Clinical Registry Manager
CVD	Cardiovascular Disease
DAPD	Daytime Ambulatory Peritoneal Dialysis
DM	Diabetes Mellitus
DOQI	Dialysis Outcome Quality Initiative
eMOSS	Malaysian Organ Sharing System (Renal)
ESRD	End Stage Renal Disease
GDP	Gross domestic product
GNI	Gross National Income
HD	Haemodialysis
HKL	Kuala Lumpur Hospital
ITT	Intention to treat
iPTH	Intact parathyroid hormone
JNC VI	Joint National Committee on management of hypertension
Kt/V	Number used to quantify hemodialysis and peritoneal dialysis treatment adequacy
LQ	Lower quartile
MDTR	Malaysian Dialysis and Transplant Registry
MOH	Ministry of Health, Malaysia
MOSS	Malaysian Organ Sharing System
MRRB	Malaysian Registry of Renal Biopsy
MSN	Malaysian Society of Nephrology
NGO	Non-governmental organization
NRIC	National Registration Identity Card
NRR	National Renal Registry, Malaysia
PD	Peritoneal dialysis
PET D/P	peritoneal transport status dialysate and plasma (D/P ratio)
pmap	per million age related population
pmp	per million population
QoL	Quality of Life
ref	Reference
RCC	Registry coordinating centre
RRT	Renal replacement therapy
SC	Site coordinator
SDP	Source data producer
SMR	Standardised Mortality Ratio
UQ	Upper quartile
URR	Urea reduction rate

CHAPTER 1

**ALL RENAL REPLACEMENT  
THERAPY IN MALAYSIA**

Lim Yam Ngo  
Ghazali Ahmad  
Ong Loke Meng  
Lee Day Guat



### SECTION 1.1: STOCK AND FLOW

The intake of new dialysis patients continued to show a linear increase - from 2112 in 2001 to 4740 in 2009 and 4522 in 2010. The number of prevalent dialysis patients has increased almost three-fold from 7837 in 2000 to almost 23,000 in 2010. (Data for 2010 however are preliminary since at the time of writing this report there was still many new patients yet to be notified to registry.)

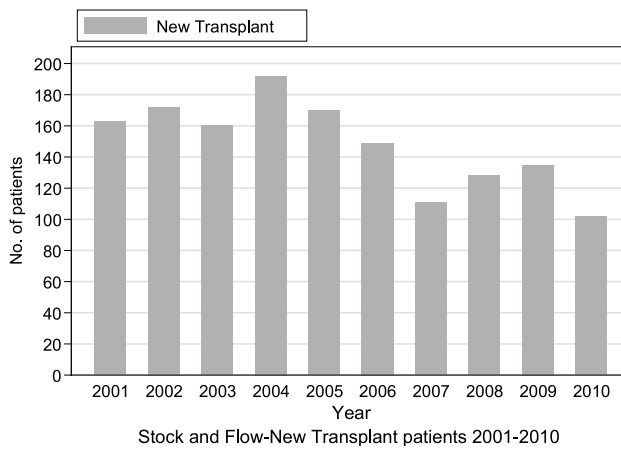
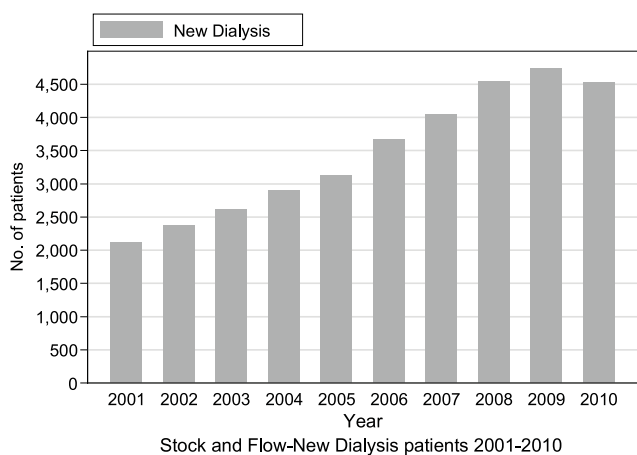
The number of new kidney transplant recipients seems to be showing a decreasing trend from 2005 due most probably to the increasing proscription against commercial transplantation. Patients with functioning renal transplants have also begun to plateau since 2006. (Table and Figure 1.1)

**Table 1.1:** Stock and Flow of RRT, Malaysia 2001-2010

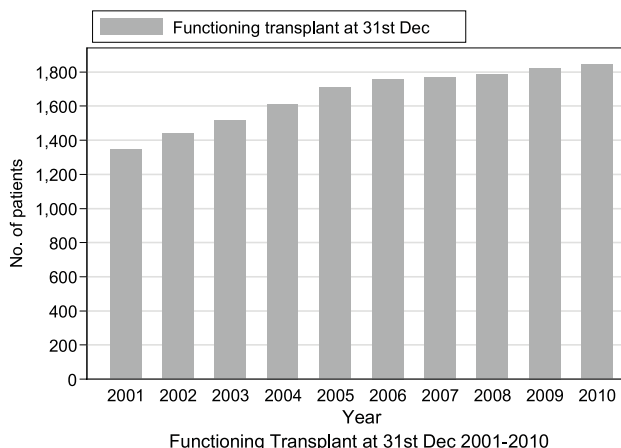
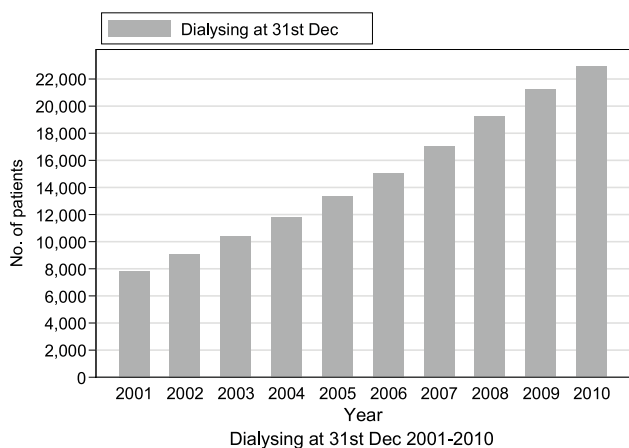
Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
New Dialysis patients	2112	2373	2620	2891	3134	3669	4047	4548	4740	4522
New Transplants	163	172	160	192	170	149	111	128	135	102
Dialysis deaths	850	959	1211	1318	1513	1815	1984	2190	2578	2574
Transplant deaths	40	38	42	44	47	58	46	60	49	33
Dialyzing at 31 <sup>st</sup> December	7837	9102	10399	11829	13332	15046	17022	19250	21245	22932
Functioning transplant at 31 <sup>st</sup> December	1343	1440	1513	1612	1708	1759	1772	1787	1822	1841

**Figure 1.1:** Stock and Flow of RRT, Malaysia 2001-2010

(a) New Dialysis and Transplant patients



(b) Patients Dialysing and with Functioning Transplant at 31<sup>st</sup> December 2001-2010



## SECTION 1.2: TREATMENT PROVISION RATE

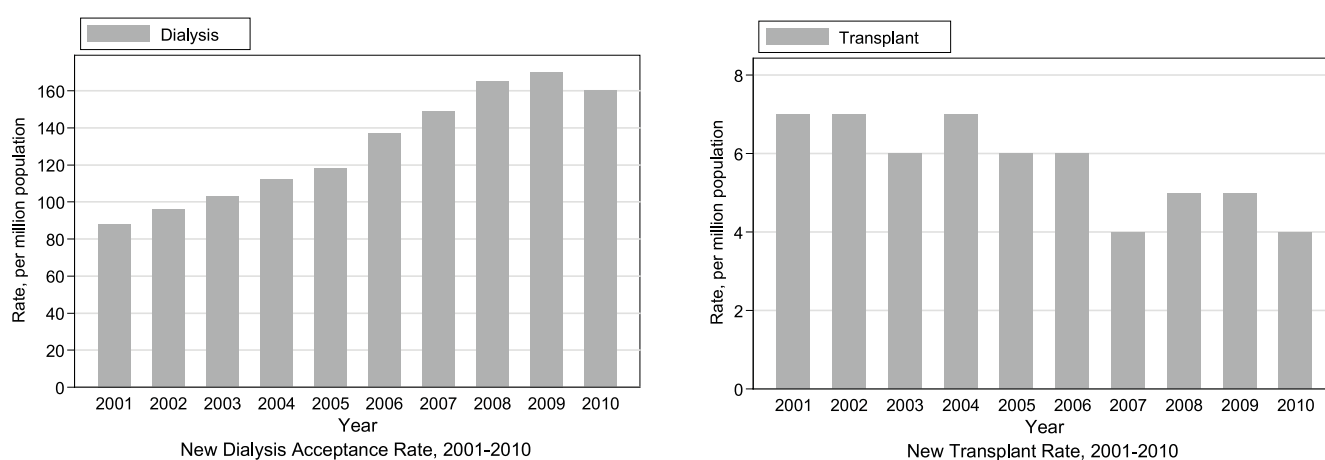
Dialysis acceptance rates increased from 88 per million population (pmp) in 2001 to 170 per million population in 2009. The acceptance rate of 160 pmp for 2010 however is preliminary since at the time of writing this report there was still many new patients yet to be notified to registry.

With the very low transplant rate, the prevalence rate of kidney transplantation has remained at 65 pmp over the last 5 years. Dialysis prevalence rate more than doubled over the last 10 years, from 325 per million population in 2001 to more than 800 per million in 2010.

**Table 1.2:** New Dialysis Acceptance rate and New Transplant Rate per million population 2001-2010

Acceptance rate	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
New Dialysis	88	96	103	112	118	137	149	165	170	160
New Transplant	7	7	6	7	6	6	4	5	5	4

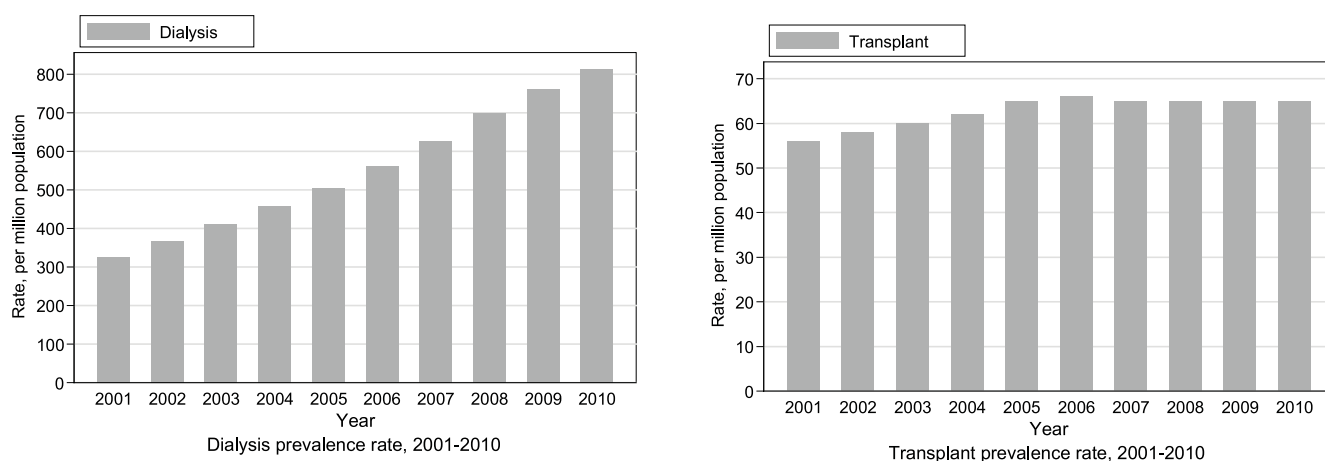
**Figure 1.2:** New Dialysis Acceptance and New Transplant Rate 2001-2010



**Table 1.3:** RRT Prevalence Rate per million population 2001-2010

Prevalence rate	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Dialysis	325	368	411	457	504	561	626	699	762	812
Transplant	56	58	60	62	65	66	65	65	65	65

**Figure 1.3:** Dialysis and Transplant Prevalence Rate per million population 2001-2010





## CHAPTER 2

# **DIALYSIS IN MALAYSIA**

Lim Yam Ngo  
Ghazali B Ahmad  
Tan Chwee Choon  
Lee Day Guat

## SECTION 2.1: PROVISION OF DIALYSIS IN MALAYSIA (registry report)

Information on provision of dialysis was obtained from data on individual patients reported to the registry shown in section 2.1 as well as from the centre survey carried out at the end of each calendar year shown in section 2.2.

### 2.1.1: Dialysis treatment provision

The number of patients commencing dialysis more than doubled in 10 years from 2112 in 2001 to 4740 in 2009 and at least 4521 in 2010 giving an acceptance rate of 88 per million population in 2001 to 170 in 2009. (Data for 2010 however are preliminary since at the time of writing this report there were still many new patients yet to be notified to registry.)

The number of dialysis patients in Malaysia has tripled in 10 years from 7837 in 2001 to more than almost 23,000 in 2010 to give a prevalence rate at least 812 pmp in 2009. There were more patients notified to the registry as lost to follow-up in 2010. Further investigations are needed ascertain whether these patients had died, had been transplanted or moved to another centre.

**Table 2.1.1:** Stock and flow-Dialysis Patients 2001-2010

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
New Dialysis patients	2112	2373	2620	2891	3134	3669	4047	4548	4740	4521
Died	850	959	1211	1318	1513	1815	1984	2190	2578	2574
Transplanted	127	143	119	157	122	121	90	110	110	93
Lost to Follow-up	9	15	19	21	26	54	28	29	70	176
Dialysing at 31 <sup>st</sup> December	7837	9102	10399	11829	13332	15046	17022	19250	21245	22932

**Table 2.1.2:** Dialysis Treatment Rate per million population 2001-2010

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Acceptance rate	88	96	103	112	118	137	149	165	170	160
Prevalence rate	325	368	411	457	504	561	626	699	762	812

### 2.1.2: Geographic distribution

From Table 2.1.3, except for Sabah, Kelantan and Perlis, dialysis acceptance rates in the other states in Malaysia have exceeded 100 per million state population. At more than 200 pmp, the economically advanced states like Pulau Pinang, Melaka, Johor, Kuala Lumpur, Selangor and Negeri Sembilan have dialysis acceptance rates more than twice higher than the least developed states.

**Table 2.1.3:** Dialysis Treatment Rate by state, per million population 2001-2010

State	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Pulau Pinang	122	157	143	210	196	211	216	198	234	228
Melaka	150	172	183	206	167	197	209	227	205	228
Johor	134	146	145	155	167	213	195	247	232	199
Perak	104	115	126	148	169	187	181	203	217	200
Selangor & Putrajaya	94	110	119	123	134	153	171	179	203	200
WP Kuala Lumpur	186	168	189	201	190	210	242	253	270	272
Negeri Sembilan	109	131	145	155	156	150	218	250	259	252
Kedah	63	89	105	98	110	119	134	169	154	128
Perlis	104	102	128	94	102	127	130	141	63	75
Terengganu	76	90	67	81	104	107	180	148	156	184
Pahang	53	51	68	75	90	124	117	145	136	137
Kelantan	59	61	74	64	78	78	93	85	112	83
Sarawak	66	58	62	72	71	86	105	117	121	114
Sabah & WP Labuan	35	36	43	44	43	62	65	95	89	81

## SECTION 2.2: DIALYSIS PROVISION IN MALAYSIA (Centre survey report)

Prior to 2006, data submission of individual dialysis and transplant patients to the National Renal Registry was entirely voluntary. Since then, with the implementation of the Private Health Care Facilities and Services Act 1998 and its Regulations in 2006, submission of data from private and Non-governmental organization (NGO) centres has been made compulsory. However, enforcement of this Act is still in the preliminary stages. In contrast, data submission from centres managed by the Ministry of Health, Ministry of Defence or the Universities is still voluntary.

Dialysis centre surveys have been conducted in December of each year since 1999. This annual cross-sectional survey was carried out to describe the most current level and distribution of dialysis provision for both hemodialysis and peritoneal dialysis at the end of each year. This section reports the results of the centre survey carried out in December 2010. This survey also collects data on available manpower in the dialysis centres which is presented in this report for the first time.

Dialysis provision is expressed in terms of number of centres, HD machines, treatment capacity (one HD machine to 5 patients) and number of patients.

### 2.2.1: Growth in dialysis in Malaysia by state and sector

The number of dialysis centres for the whole of Malaysia increased from 230 in 2001 to 398 in 2005 and 618 in 2010 giving a rate of 10 per million population (pmp) in 2001 and 22 pmp in 2010. The increase in dialysis centres were mainly contributed by the private dialysis centres which had grown from 3 pmp in 2001 to 11 pmp in 2010. The public sector had only increased from 4 pmp in 2001 to 6 pmp in 2010 while the NGO dialysis centres had an increase from 3 pmp to 5 pmp over the same period. Most of the increases in the private dialysis centres occurred in the more economically developed west coast states of Malaysian Peninsula. (Table and Figures 2.2.1)

As can be seen from Tables 2.2.3 and 2.2.3, the proliferation of hemodialysis centres accounted for most of the increase in dialysis centres. PD centre rate remained at 1 pmp throughout the last 10 years in contrast to HD centres which had increased from 9 to 21 pmp over the same period. Of the 37 PD centres, only 9 were private centres with a total of 41 patients. Three private PD centres in Johor accounted for 35 PD patients while the other 6 centres had one patient each (Table 22.7). There were no NGO dialysis centres providing chronic PD treatment.

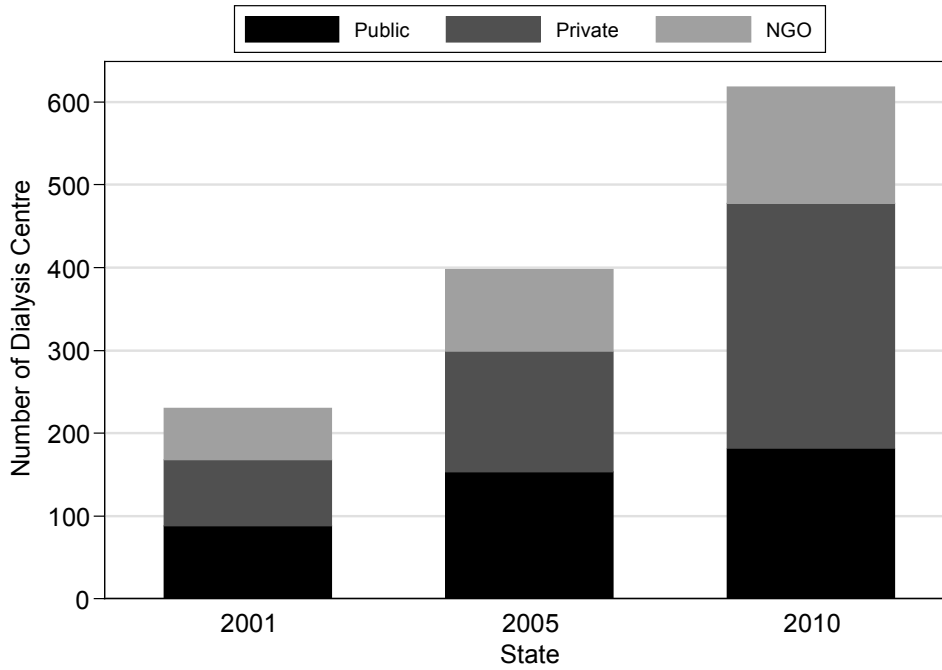
**Table 2.2.1:** Number and density of Dialysis Centres in Malaysia by State and Sector, 2001-2010

State	Sector	2001		2005		2010	
		n	pmp	n	pmp	n	pmp
Malaysia	Public	88	4	153	6	181	6
Malaysia	Private	80	3	145	5	297	11
Malaysia	NGO	62	3	100	4	140	5
Malaysia	Total	230	10	398	15	618	22
Perlis	Public	1	5	1	4	1	4
Perlis	Private	-	-	-	-	-	-
Perlis	NGO	-	-	1	4	1	4
Perlis	Total	1	5	2	9	2	8
Kedah	Public	9	5	10	5	11	6
Kedah	Private	7	4	12	7	21	11
Kedah	NGO	3	2	5	3	6	3
Kedah	Total	19	11	27	15	38	19
Kedah & Perlis	Public	10	5	11	5	12	5
Kedah & Perlis	Private	7	4	12	6	21	10
Kedah & Perlis	NGO	3	2	6	3	7	3
Kedah & Perlis	Total	20	10	29	14	40	18
Pulau Pinang	Public	4	3	8	5	10	6
Pulau Pinang	Private	11	8	12	8	27	17
Pulau Pinang	NGO	7	5	14	9	20	13
Pulau Pinang	Total	22	16	34	23	57	36
Perak	Public	7	3	17	7	19	8
Perak	Private	10	5	19	8	31	13
Perak	NGO	5	2	12	5	13	5
Perak	Total	22	10	48	21	63	26

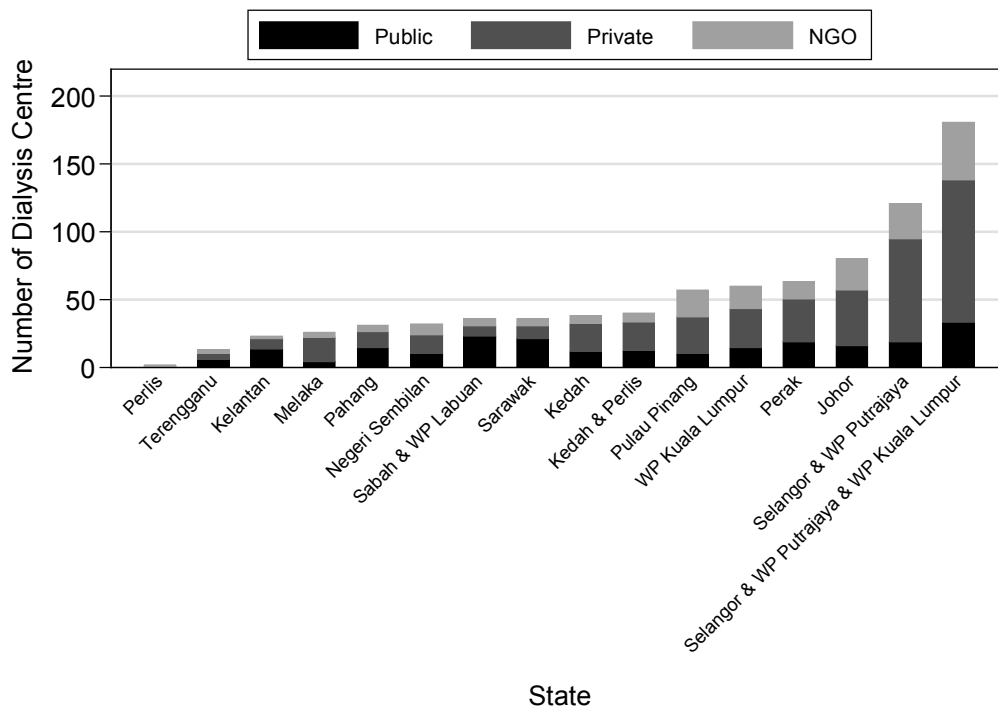
**Table 2.2.1:** Number and density of Dialysis Centres in Malaysia by State and Sector, 2001-2010 (cont'd.)

State	Sector	2001		2005		2010	
		n	pmp	n	pmp	n	pmp
Selangor & WP Putrajaya	Public	10	2	14	3	19	4
Selangor & WP Putrajaya	Private	16	4	33	7	76	15
Selangor & WP Putrajaya	NGO	9	2	18	4	26	5
Selangor & WP Putrajaya	Total	35	8	65	14	121	24
WP Kuala Lumpur	Public	13	9	13	8	14	8
WP Kuala Lumpur	Private	14	10	24	15	29	17
WP Kuala Lumpur	NGO	7	5	10	6	17	10
WP Kuala Lumpur	Total	34	23	47	29	60	35
Selangor & WP Putrajaya & WP KL	Public	23	4	27	4	33	5
Selangor & WP Putrajaya & WP KL	Private	30	5	57	9	105	15
Selangor & WP Putrajaya & WP KL	NGO	16	3	28	4	43	6
Selangor & WP Putrajaya & WP KL	Total	69	12	112	18	181	27
Negeri Sembilan	Public	3	3	6	6	10	1
Negeri Sembilan	Private	2	2	2	2	14	14
Negeri Sembilan	NGO	3	3	4	4	8	8
Negeri Sembilan	Total	8	9	12	13	32	32
Melaka	Public	3	5	4	6	4	5
Melaka	Private	6	9	9	12	18	23
Melaka	NGO	3	5	3	4	4	5
Melaka	Total	12	18	16	22	26	34
Johor	Public	8	3	14	4	16	5
Johor	Private	7	2	20	6	41	12
Johor	NGO	15	5	20	6	23	7
Johor	Total	30	11	54	17	80	24
Pahang	Public	4	3	10	7	14	9
Pahang	Private	1	1	2	1	12	8
Pahang	NGO	2	2	3	2	5	3
Pahang	Total	7	5	15	1	31	20
Terengganu	Public	5	5	6	6	6	6
Terengganu	Private	-	-	2	2	4	4
Terengganu	NGO	1	1	2	2	3	3
Terengganu	Total	6	7	10	10	13	12
Kelantan	Public	7	5	12	8	13	8
Kelantan	Private	1	1	3	2	8	5
Kelantan	NGO	1	1	1	1	2	1
Kelantan	Total	9	6	16	10	23	14
Sabah & WP Labuan	Public	7	3	20	6	23	7
Sabah & WP Labuan	Private	2	1	3	1	7	2
Sabah & WP Labuan	NGO	3	1	4	1	6	2
Sabah & WP Labuan	Total	12	4	27	9	36	11
Sarawak	Public	7	3	18	8	21	8
Sarawak	Private	3	1	4	2	9	4
Sarawak	NGO	3	1	3	1	6	2
Sarawak	Total	13	6	25	11	36	14

**Figure 2.2.1(a):** Number of Dialysis Centre in Malaysia by Sector, 2001-2010



**Figure 2.2.1(b):** Number of Dialysis Centre in Malaysia by State and Sector in 2010





**Table 2.2.2:** Number and density of HD centres in Malaysia by State and Sector, 2001-2010

State	Sector	2001		2005		2010	
		n	pmp	n	pmp	n	pmp
Malaysia	Public	71	3	134	5	153	5
Malaysia	Private	75	3	139	5	288	10
Malaysia	NGO	62	3	99	4	140	5
Malaysia	Total	208	9	372	14	581	21
Perlis	Public	1	5	1	4	1	4
Perlis	Private	-	-	-	-	-	-
Perlis	NGO	-	-	1	4	1	4
Perlis	Total	1	5	2	9	2	8
Kedah	Public	9	5	10	5	10	5
Kedah	Private	7	4	12	7	21	11
Kedah	NGO	3	2	5	3	6	3
Kedah	Total	19	11	27	15	37	19
Kedah & Perlis	Public	10	5	11	5	11	5
Kedah & Perlis	Private	7	4	12	6	21	10
Kedah & Perlis	NGO	3	2	6	3	7	3
Kedah & Perlis	Total	20	10	29	14	39	18
Pulau Pinang	Public	3	2	7	5	8	5
Pulau Pinang	Private	10	7	11	7	26	16
Pulau Pinang	NGO	7	5	14	9	20	13
Pulau Pinang	Total	20	15	32	21	54	34
Perak	Public	6	3	15	7	17	7
Perak	Private	9	4	18	8	30	12
Perak	NGO	5	2	12	5	13	5
Perak	Total	20	9	45	20	60	24
Selangor & WP Putrajaya	Public	8	2	12	3	15	3
Selangor & WP Putrajaya	Private	15	3	32	7	75	15
Selangor & WP Putrajaya	NGO	9	2	17	4	26	5
Selangor & WP Putrajaya	Total	32	7	61	13	116	23
WP Kuala Lumpur	Public	9	6	9	6	10	6
WP Kuala Lumpur	Private	14	10	24	15	29	17
WP Kuala Lumpur	NGO	7	5	10	6	17	10
WP Kuala Lumpur	Total	30	20	43	27	56	33
Selangor & WP Putrajaya & WP KL	Public	17	3	21	3	25	4
Selangor & WP Putrajaya & WP KL	Private	29	5	56	9	104	15
Selangor & WP Putrajaya & WP KL	NGO	16	3	27	4	43	6
Selangor & WP Putrajaya & WP KL	Total	62	11	104	16	172	25
Negeri Sembilan	Public	2	2	5	5	8	8
Negeri Sembilan	Private	2	2	2	2	14	14
Negeri Sembilan	NGO	3	3	4	4	8	8
Negeri Sembilan	Total	7	8	11	12	30	30
Melaka	Public	2	3	3	4	3	4
Melaka	Private	5	8	8	11	17	22
Melaka	NGO	3	5	3	4	4	5
Melaka	Total	10	15	14	19	24	31
Johor	Public	7	2	12	4	13	4
Johor	Private	7	2	19	6	38	11
Johor	NGO	15	5	20	6	23	7
Johor	Total	29	10	51	16	74	22
Pahang	Public	3	2	9	6	12	8
Pahang	Private	1	1	2	1	12	8
Pahang	NGO	2	2	3	2	5	3
Pahang	Total	6	5	14	10	29	19

**Table 2.2.2:** Number and density of HD centres in Malaysia by State and Sector, 2001-2010 (cont'd.)

State	Sector	2001		2005		2010	
		n	pmp	n	pmp	n	pmp
Terengganu	Public	4	4	5	5	5	5
Terengganu	Private	-	-	2	2	4	4
Terengganu	NGO	1	1	2	2	3	3
Terengganu	Total	5	5	9	9	12	11
Kelantan	Public	5	4	10	7	11	7
Kelantan	Private	1	1	3	2	8	5
Kelantan	NGO	1	1	1	1	2	1
Kelantan	Total	7	5	14	9	21	13
Sabah & WP Labuan	Public	6	2	19	6	20	6
Sabah & WP Labuan	Private	1	0	2	1	6	2
Sabah & WP Labuan	NGO	3	1	4	1	6	2
Sabah & WP Labuan	Total	10	4	25	8	32	10
Sarawak	Public	6	3	17	7	20	8
Sarawak	Private	3	1	4	2	8	3
Sarawak	NGO	3	1	3	1	6	2
Sarawak	Total	12	6	24	10	34	14

**Table 2.2.3:** Number and density of PD centres in Malaysia by State and Sector, 2001-2010

State	Sector	2001		2005		2010	
		n	pmp	n	pmp	n	pmp
Malaysia	Public	17	100	19	1	28	1
Malaysia	Private	5	0	6	0	9	0
Malaysia	NGO	-	-	-	-	-	-
Malaysia	Total	22	100	25	1	37	1
Perlis	Public	-	-	-	-	-	-
Perlis	Private	-	-	-	-	-	-
Perlis	NGO	-	-	-	-	-	-
Perlis	Total	-	-	-	-	-	-
Kedah	Public	-	-	-	-	1	1
Kedah	Private	-	-	-	-	-	-
Kedah	NGO	-	-	-	-	-	-
Kedah	Total	-	-	-	-	1	1
Kedah & Perlis	Public	-	-	-	-	1	0
Kedah & Perlis	Private	-	-	-	-	-	-
Kedah & Perlis	NGO	-	-	-	-	-	-
Kedah & Perlis	Total	-	-	-	-	1	0
Pulau Pinang	Public	1	1	1	1	2	1
Pulau Pinang	Private	1	1	1	1	1	1
Pulau Pinang	NGO	-	-	-	-	-	-
Pulau Pinang	Total	2	1	2	1	3	2
Perak	Public	1	0	2	1	2	1
Perak	Private	1	0	1	0	1	0
Perak	NGO	-	-	-	-	-	-
Perak	Total	2	1	3	1	3	1
Selangor & WP Putrajaya	Public	2	0	2	0	4	1
Selangor & WP Putrajaya	Private	1	0	1	0	1	0
Selangor & WP Putrajaya	NGO	-	-	-	-	-	-
Selangor & WP Putrajaya	Total	3	1	3	1	5	1
WP Kuala Lumpur	Public	4	3	4	2	4	2
WP Kuala Lumpur	Private	-	-	-	-	-	-
WP Kuala Lumpur	NGO	-	-	-	-	-	-
WP Kuala Lumpur	Total	4	0	4	2	4	0

**Table 2.2.3:** Number and density of PD centres in Malaysia by State and Sector, 2001-2010 (cont'd.)

State	Sector	2001		2005		2010	
		n	pmp	n	pmp	n	pmp
Selangor & WP Putrajaya & WP KL	Public	6	1	6	1	8	1
Selangor & WP Putrajaya & WP KL	Private	1	0	1	0	1	0
Selangor & WP Putrajaya & WP KL	NGO	-	-	-	-	-	-
Selangor & WP Putrajaya & WP KL	Total	7	1	7	1	9	1
Negeri Sembilan	Public	1	1	1	1	2	2
Negeri Sembilan	Private	-	-	-	-	-	-
Negeri Sembilan	NGO	-	-	-	-	-	-
Negeri Sembilan	Total	1	1	1	1	2	2
Melaka	Public	1	2	1	1	1	1
Melaka	Private	1	2	1	1	1	1
Melaka	NGO	-	-	-	-	-	-
Melaka	Total	2	3	2	3	2	3
Johor	Public	1	0	2	1	3	1
Johor	Private	-	-	1	0	3	1
Johor	NGO	-	-	-	-	-	-
Johor	Total	1	0	3	1	6	2
Pahang	Public	1	1	1	1	2	1
Pahang	Private	-	-	-	-	-	-
Pahang	NGO	-	-	-	-	-	-
Pahang	Total	1	1	1	1	2	1
Terengganu	Public	1	1	1	1	1	1
Terengganu	Private	-	-	-	-	-	-
Terengganu	NGO	-	-	-	-	-	-
Terengganu	Total	1	1	1	1	1	1
Kelantan	Public	2	1	2	1	2	1
Kelantan	Private	-	-	-	-	-	-
Kelantan	NGO	-	-	-	-	-	-
Kelantan	Total	2	1	2	1	2	1
Sabah & WP Labuan	Public	1	0	1	0	3	1
Sabah & WP Labuan	Private	1	0	1	0	1	0
Sabah & WP Labuan	NGO	-	-	-	-	-	-
Sabah & WP Labuan	Total	2	1	2	1	4	1
Sarawak	Public	1	0	1	0	1	0
Sarawak	Private	-	-	-	-	1	0
Sarawak	NGO	-	-	-	-	-	-
Sarawak	Total	1	0	1	0	2	1

The number of hemodialysis machines increase from 820 in 2001 to 2144 in 2010 giving rates of 96 and 230 haemodialysis machines pmp respectively. Not surprisingly, the increase was the most rapid in the private sector as shown in Figure 2.2.4 (a) paralleling the increase in the number of HD patients as shown in Figure 2.2.5 (a).

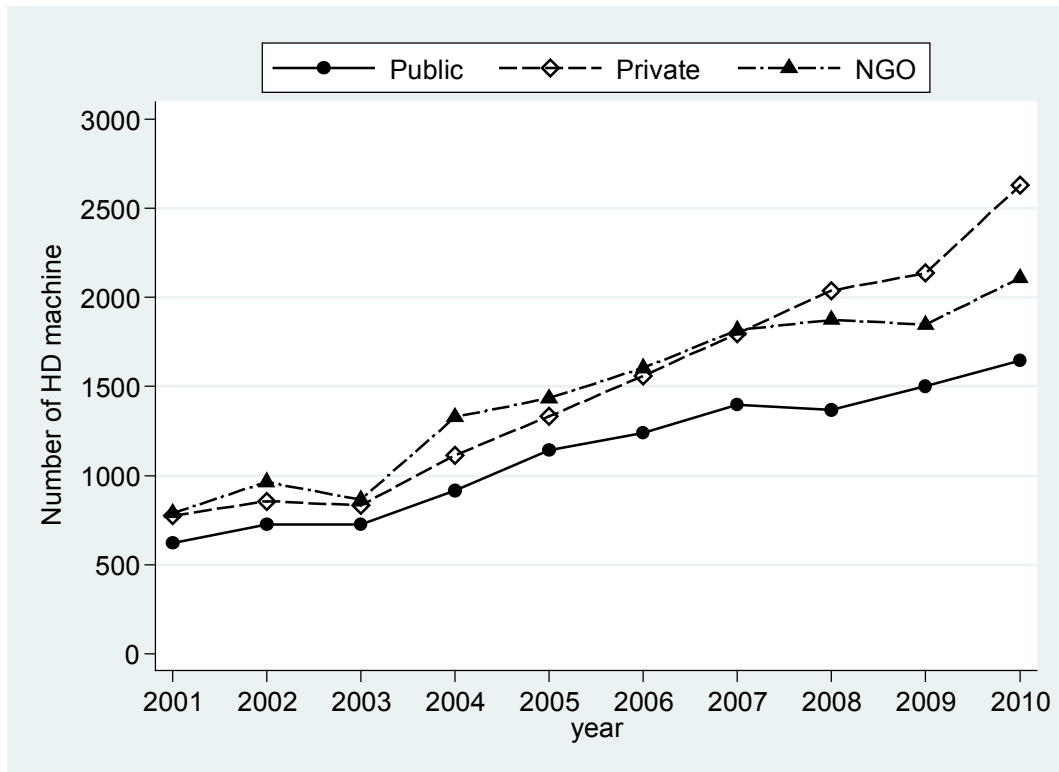
**Table 2.2.4:** Number and density of HD machines in Malaysia by State and Sector, 2001-2010

State	Sector	2001		2005		2010	
		n	pmp	n	pmp	n	pmp
Malaysia	Public	648	-	1174	44	1687	60
Malaysia	Private	858	27	1442	54	2665	94
Malaysia	NGO	820	36	1463	55	2144	76
Malaysia	Total	2326	34	4079	154	6496	230
Perlis	Public	15	96	25	111	32	133
Perlis	Private	-	71	-	-	-	-
Perlis	NGO	-	-	10	44	15	62
Perlis	Total	15	-!	35	155	47	196
Kedah	Public	50	71	82	45	110	56
Kedah	Private	50	29	122	66	164	83
Kedah	NGO	27	29	63	34	81	41
Kedah	Total	127	16	267	145	355	180
Kedah & Perlis	Public	65	74	107	52	142	64
Kedah & Perlis	Private	50	34	122	59	164	74
Kedah & Perlis	NGO	27	26	73	35	96	43
Kedah & Perlis	Total	142	14	302	146	402	182
Pulau Pinang	Public	49	74	57	38	93	59
Pulau Pinang	Private	150	36	182	121	276	174
Pulau Pinang	NGO	79	109	143	95	249	157
Pulau Pinang	Total	278	58	382	254	618	389
Perak	Public	62	203	126	55	171	69
Perak	Private	141	29	188	82	309	126
Perak	NGO	71	66	160	70	205	83
Perak	Total	274	33	474	206	685	278
Selangor & WP Putrajaya	Public	75	128	148	31	205	40
Selangor & WP Putrajaya	Private	151	17	302	64	669	131
Selangor & WP Putrajaya	NGO	129	35	301	64	391	77
Selangor & WP Putrajaya	Total	355	30	751	159	1265	248
WP Kuala Lumpur	Public	81	82	80	49	100	58
WP Kuala Lumpur	Private	151	55	238	147	314	182
WP Kuala Lumpur	NGO	98	103	147	91	237	138
WP Kuala Lumpur	Total	330	67	465		651	
Selangor & WP Putrajaya & WP KL	Public	156		228	36	305	45
Selangor & WP Putrajaya & WP KL	Private	302	27	540	85	983	144
Selangor & WP Putrajaya & WP KL	NGO	227	52	448	70	628	92
Selangor & WP Putrajaya & WP KL	Total	685	39	1216	191	1916	281
Negeri Sembilan	Public	23	119	43	45	78	77
Negeri Sembilan	Private	10	26	14	15	87	86
Negeri Sembilan	NGO	48	11	79	83	149	147
Negeri Sembilan	Total	81	54	136	142	314	310

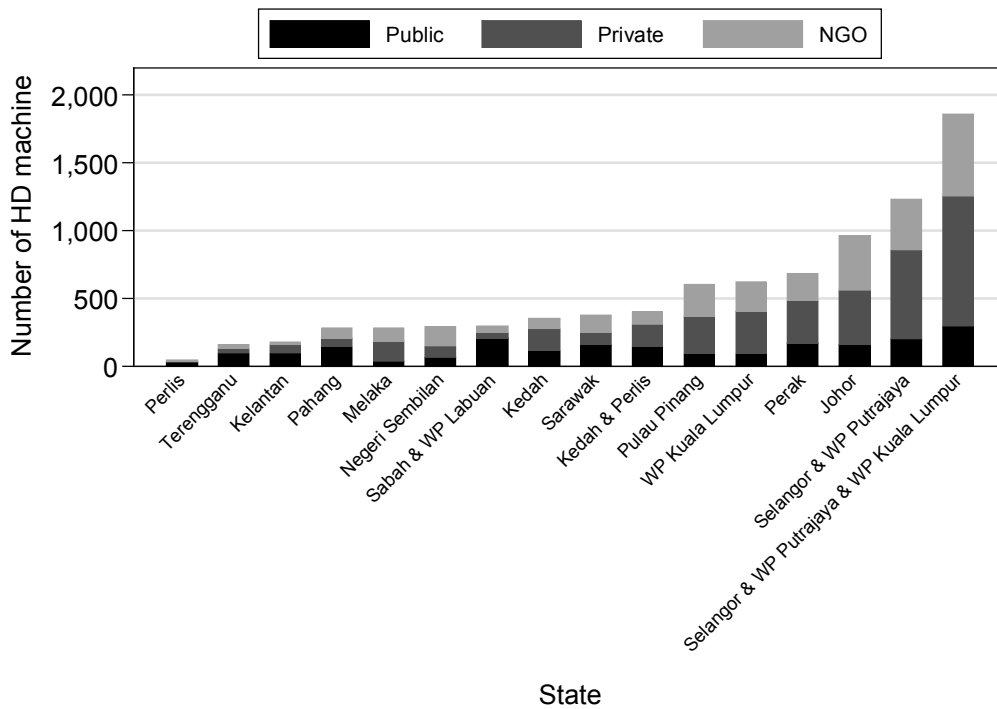
**Table 2.2.4:** Number and density of HD machines in Malaysia by State and Sector, 2001-2010 (cont'd.)

State	Sector	2001		2005		2010	
		n	pmp	n	pmp	n	pmp
Melaka	Public	22	91	29	40	38	49
Melaka	Private	48	33	76	105	154	200
Melaka	NGO	77	72	86	119	101	131
Melaka	Total	147	116	191	264	293	380
Johor	Public	64	221	121	39	162	49
Johor	Private	82	22	192	62	405	123
Johor	NGO	198	29	314	101	398	120
Johor	Total	344	69	627	201	965	292
Pahang	Public	26	121	93	64	142	91
Pahang	Private	8	20	16	11	67	43
Pahang	NGO	18	6	32	22	78	50
Pahang	Total	52	14	141	97	287	185
Terengganu	Public	30	39	53	54	95	90
Terengganu	Private	-	33	7	7	30	29
Terengganu	NGO	12	-	19	19	33	31
Terengganu	Total	42	13	79	80	158	150
Kelantan	Public	39	46	67	44	92	55
Kelantan	Private	24	28	40	26	62	37
Kelantan	NGO	10	17	10	7	24	14
Kelantan	Total	73	7	117	77	178	107
Sabah & WP Labuan	Public	57	52	143	45	213	64
Sabah & WP Labuan	Private	5	21	9	3	38	11
Sabah & WP Labuan	NGO	16	2	28	9	51	15
Sabah & WP Labuan	Total	78	6	180	57	302	91
Sarawak	Public	55	29	107	46	156	62
Sarawak	Private	38	26	56	24	90	36
Sarawak	NGO	37	18	71	31	132	53
Sarawak	Total	130	17	234	101	378	151

**Figure 2.2.4(a):** Number of HD machines in Malaysia by Sector from 2001-2010



**Figure 2.2.4(b):** Number of HD machines in Malaysia by State and Sector in 2010



The total number of dialysis patients increased from 7579 (314 per million population) in 2001 to 23420 (829 pmp) in 2010. The rate of rise in dialysis provision in the public and NGO sectors were almost similar – from 117 pmp for public sector and 101 pmp for NGO sector in 2001; to 252 for public and 230 pmp for NGO sector respectively in 2010. Dialysis provision in the private sector showed the steepest increase from 97 pmp in 2001 to 347 pmp in 2010.

Distribution by state showed that the economically advanced states of Malaysia have more patients in NGO and private dialysis centres whereas in the states of Sabah, Sarawak, Kelantan and Terengganu, the public sector patients accounted for at least half of the dialysis patients.

**Table 2.2.5:** Number and Prevalence Rate of Dialysis Patients (HD & PD) in Malaysia by State and Sector, 2001-2010

State	Sector	2001		2005		2010	
		n	pmp	n	pmp	n	pmp
Malaysia	Public	2815	117	4872	184	7115	252
Malaysia	Private	2333	97	4184	158	9813	347
Malaysia	NGO	2431	101	4208	159	6492	230
Malaysia	Total	7579	314	13264	501	23420	829
Perlis	Public	50	236	88	389	86	358
Perlis	Private	-	-	-	-	-	-
Perlis	NGO	-	-	12	53	41	171
Perlis	Total	50	236	100	442	127	529
Kedah	Public	178	104	280	152	416	212
Kedah	Private	111	65	268	145	606	308
Kedah	NGO	85	50	178	97	263	134
Kedah	Total	374	218	726	394	1285	653
Kedah & Perlis	Public	228	119	368	178	502	227
Kedah & Perlis	Private	111	58	268	130	606	275
Kedah & Perlis	NGO	85	44	190	92	304	138
Kedah & Perlis	Total	424	220	826	399	1412	640
Pulau Pinang	Public	203	148	280	187	413	260
Pulau Pinang	Private	428	312	558	372	911	574
Pulau Pinang	NGO	187	136	412	274	679	428
Pulau Pinang	Total	818	596	1250	833	2003	1262
Perak	Public	235	110	356	155	511	208
Perak	Private	333	156	593	258	1278	519
Perak	NGO	213	100	410	178	634	258
Perak	Total	781	365	1359	591	2423	985
Selangor & WP Putrajaya	Public	231	54	547	115	919	180
Selangor & WP Putrajaya	Private	407	94	944	199	2302	451
Selangor & WP Putrajaya	NGO	363	84	753	159	1093	214
Selangor & WP Putrajaya	Total	1001	232	2244	474	4314	845
WP Kuala Lumpur	Public	510	348	712	440	599	348
WP Kuala Lumpur	Private	459	314	660	408	1017	590
WP Kuala Lumpur	NGO	415	284	462	285	721	419
WP Kuala Lumpur	Total	1384	946	1834	1132	2337	1357
Selangor & WP Putrajaya & WP KL	Public	741	128	1259	198	1518	222
Selangor & WP Putrajaya & WP KL	Private	866	150	1604	252	3319	486
Selangor & WP Putrajaya & WP KL	NGO	778	135	1215	191	1814	266
Selangor & WP Putrajaya & WP KL	Total	2385	413	4078	641	6651	974

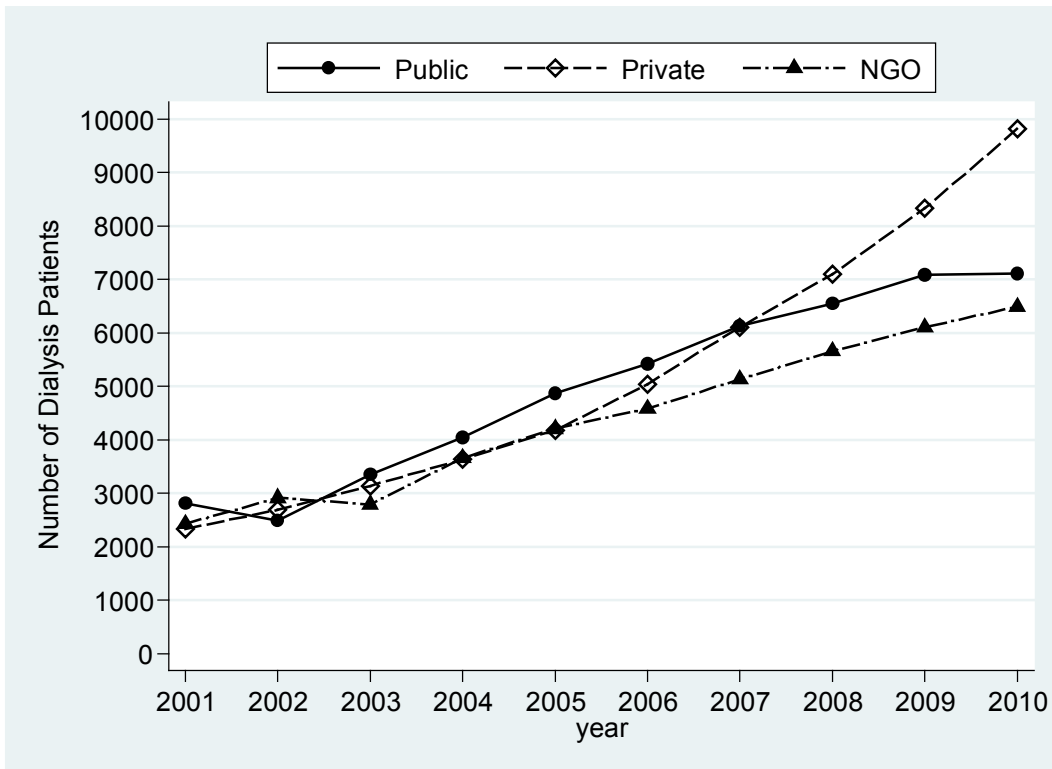
**Table 2.2.5:** Number and Prevalence Rate of Dialysis Patients (HD & PD) in Malaysia by State and Sector, 2001-2010 (cont'd.)

State	Sector	2001		2005		2010	
		n	pmp	n	pmp	n	pmp
Negeri Sembilan	Public	146	164	222	232	207	205
Negeri Sembilan	Private	12	14	53	55	287	284
Negeri Sembilan	NGO	148	167	365	382	519	513
Negeri Sembilan	Total	306	345	640	669	1013	1001
Melaka	Public	72	108	128	177	175	227
Melaka	Private	113	170	221	306	455	590
Melaka	NGO	186	280	237	328	223	289
Melaka	Total	371	558	586	810	853	1106
Johor	Public	356	125	621	199	757	229
Johor	Private	258	91	544	175	1919	580
Johor	NGO	593	208	928	298	1268	384
Johor	Total	1207	423	2093	671	3944	1193
Pahang	Public	110	83	277	191	532	342
Pahang	Private	38	29	39	27	210	135
Pahang	NGO	46	35	75	52	202	130
Pahang	Total	194	146	391	270	944	607
Terengganu	Public	138	150	269	273	445	424
Terengganu	Private	-	-	17	17	117	111
Terengganu	NGO	32	35	48	49	125	119
Terengganu	Total	170	184	334	339	687	654
Kelantan	Public	101	72	263	172	424	254
Kelantan	Private	44	31	100	65	238	142
Kelantan	NGO	20	14	36	24	77	46
Kelantan	Total	165	118	399	261	739	442
Sabah & WP Labuan	Public	266	98	444	140	898	271
Sabah & WP Labuan	Private	4	1	13	4	119	36
Sabah & WP Labuan	NGO	30	11	74	23	146	44
Sabah & WP Labuan	Total	300	110	531	168	1163	351
Sarawak	Public	219	103	385	165	733	292
Sarawak	Private	126	59	174	75	354	141
Sarawak	NGO	113	53	218	94	501	200
Sarawak	Total	458	215	777	334	1588	634

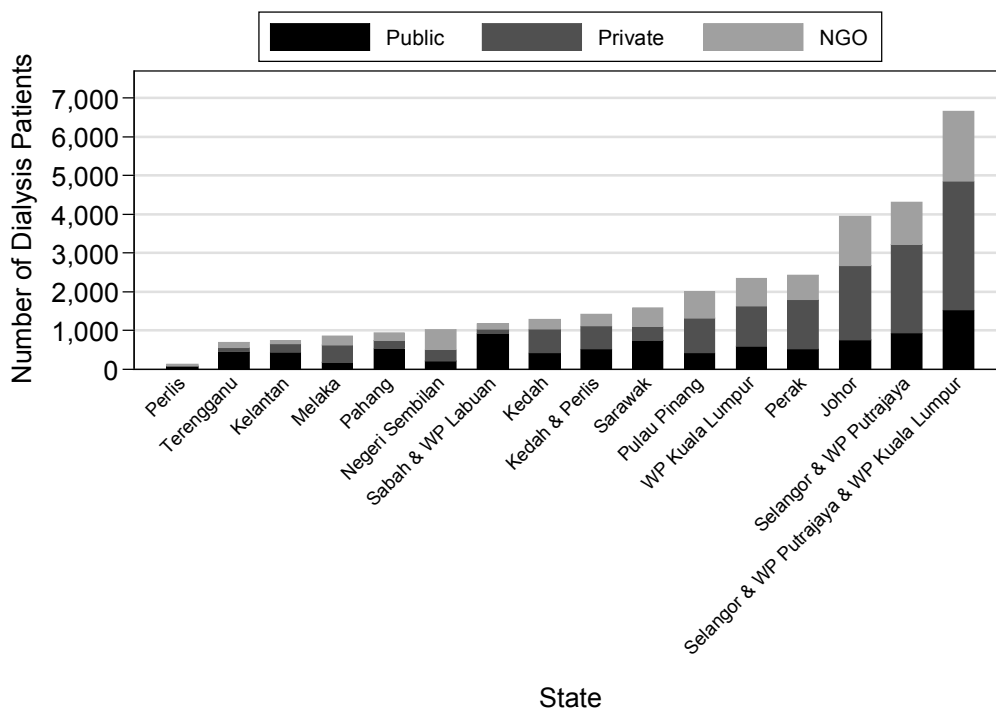
PMP = per million population



**Figure 2.2.5(a):** Number of Dialysis Patients (HD+PD) in Malaysia by Sector from 2001-2010



**Figure 2.2.5(b):** Number of Dialysis Patients (HD&PD) in Malaysia by State and Sector in 2010



**Table 2.2.6:** Number and Prevalence Rate of Hemodialysis Patients in Malaysia by State and Sector, 2001-2010

State	Sector	2001		2005		2010	
		n	pmp	n	pmp	n	pmp
Malaysia	Public	2042	85	3668	139	5375	190
Malaysia	Private	2328	97	4170	157	9772	346
Malaysia	NGO	2431	101	4208	159	6492	230
Malaysia	Total	6801	282	12046	455	21639	766
Perlis	Public	50	236	88	389	86	358
Perlis	Private	-	-	-	-	-	-
Perlis	NGO	-	-	12	53	41	171
Perlis	Total	50	236	100	442	127	529
Kedah	Public	178	104	280	152	378	192
Kedah	Private	111	65	268	145	606	308
Kedah	NGO	85	50	178	97	263	134
Kedah	Total	374	218	726	394	1247	634
Kedah & Perlis	Public	228	119	368	178	464	210
Kedah & Perlis	Private	111	58	268	130	606	275
Kedah & Perlis	NGO	85	44	190	92	304	138
Kedah & Perlis	Total	424	220	826	399	1374	623
Pulau Pinang	Public	103	75	158	105	213	134
Pulau Pinang	Private	427	311	558	372	911	574
Pulau Pinang	NGO	187	136	412	274	679	428
Pulau Pinang	Total	717	523	1128	751	1803	1136
Perak	Public	192	90	314	136	419	170
Perak	Private	332	155	591	257	1278	519
Perak	NGO	213	100	410	178	634	258
Perak	Total	737	344	1315	572	2331	947
Selangor & WP Putrajaya	Public	179	41	437	92	514	101
Selangor & WP Putrajaya	Private	405	94	944	199	2301	451
Selangor & WP Putrajaya	NGO	363	84	753	159	1093	214
Selangor & WP Putrajaya	Total	947	219	2134	450	3908	766
WP Kuala Lumpur	Public	189	129	290	179	250	145
WP Kuala Lumpur	Private	459	314	660	408	1017	590
WP Kuala Lumpur	NGO	415	284	462	285	721	419
WP Kuala Lumpur	Total	1063	726	1412	872	1988	1154
Selangor & WP Putrajaya & WP KL	Public	368	64	727	114	764	112
Selangor & WP Putrajaya & WP KL	Private	864	149	1604	252	3318	486
Selangor & WP Putrajaya & WP KL	NGO	778	135	1215	191	1814	266
Selangor & WP Putrajaya & WP KL	Total	2010	348	3546	558	5896	864
Negeri Sembilan	Public	82	92	159	166	189	187
Negeri Sembilan	Private	12	14	53	55	287	284
Negeri Sembilan	NGO	148	167	365	382	519	513
Negeri Sembilan	Total	242	273	577	603	995	983
Melaka	Public	71	107	97	134	128	166
Melaka	Private	113	170	219	303	454	588
Melaka	NGO	186	280	237	328	223	289
Melaka	Total	370	556	553	765	805	1043

**Table 2.2.6:** Number and Prevalence Rate of Hemodialysis Patients in Malaysia by State and Sector, 2001-2010 (cont'd.)

State	Sector	2001		2005		2010	
		n	pmp	n	pmp	n	pmp
Johor	Public	252	88	438	141	612	185
Johor	Private	258	91	534	171	1884	570
Johor	NGO	593	208	928	298	1268	384
Johor	Total	1103	387	1900	610	3764	1139
Pahang	Public	102	77	240	166	452	291
Pahang	Private	38	29	39	27	210	135
Pahang	NGO	46	35	75	52	202	130
Pahang	Total	186	140	354	245	864	556
Terengganu	Public	96	104	206	209	317	302
Terengganu	Private	-	-	17	17	117	111
Terengganu	NGO	32	35	48	49	125	119
Terengganu	Total	128	139	271	275	559	532
Kelantan	Public	93	66	228	149	354	212
Kelantan	Private	44	31	100	65	238	142
Kelantan	NGO	20	14	36	24	77	46
Kelantan	Total	157	112	364	238	669	400
Sabah & WP Labuan	Public	245	90	396	125	815	246
Sabah & WP Labuan	Private	3	1	13	4	119	36
Sabah & WP Labuan	NGO	30	11	74	23	146	44
Sabah & WP Labuan	Total	278	102	483	153	1080	326
Sarawak	Public	210	99	337	145	648	259
Sarawak	Private	126	59	174	75	350	140
Sarawak	NGO	113	53	218	94	501	200
Sarawak	Total	449	211	729	313	1499	598

PMP = per million population

**Table 2.2.7:** Number and Prevalence Rate of PD Patients in Malaysia by State and Sector, 2001-2010

State	Sector	2001		2005		2010	
		n	pmp	n	pmp	n	pmp
Malaysia	Public	773	32	1204	45	1740	62
Malaysia	Private	5	0	14	1	41	1
Malaysia	NGO	-	-	-	-	-	-
Malaysia	Total	778	32	1218	46	1781	63
Perlis	Public	-	-	-	-	-	-
Perlis	Private	-	-	-	-	-	-
Perlis	NGO	-	-	-	-	-	-
Perlis	Total	-	-	-	-	-	-
Kedah	Public	-	-	-	-	38	19
Kedah	Private	-	-	-	-	-	-
Kedah	NGO	-	-	-	-	-	-
Kedah	Total	-	-	-	-	38	19
Kedah & Perlis	Public	-	-	-	-	38	17
Kedah & Perlis	Private	-	-	-	-	-	-
Kedah & Perlis	NGO	-	-	-	-	-	-
Kedah & Perlis	Total	-	-	-	-	38	17
Pulau Pinang	Public	100	73	122	81	200	126
Pulau Pinang	Private	1	1	-	-	-	-
Pulau Pinang	NGO	-	-	-	-	-	-
Pulau Pinang	Total	101	74	122	81	200	126

**Table 2.2.7:** Number and Prevalence Rate of PD Patients in Malaysia by State and Sector, 2001-2010 (cont'd.)

State	Sector	2001		2005		2010	
		n	pmp	n	pmp	n	pmp
Perak	Public	43	20	42	18	92	37
Perak	Private	1	0	2	1	-	-
Perak	NGO	-	-	-	-	-	-
Perak	Total	44	21	44	19	92	37
Selangor & WP Putrajaya	Public	52	12	110	23	405	79
Selangor & WP Putrajaya	Private	2	0	-	-	1	0
Selangor & WP Putrajaya	NGO	-	-	-	-	-	-
Selangor & WP Putrajaya	Total	54	13	110	23	406	80
WP Kuala Lumpur	Public	321	219	422	261	349	203
WP Kuala Lumpur	Private	-	-	-	-	-	-
WP Kuala Lumpur	NGO	-	-	-	-	-	-
WP Kuala Lumpur	Total	321	219	422	261	349	203
Selangor & WP Putrajaya & WP KL	Public	373	65	532	84	754	110
Selangor & WP Putrajaya & WP KL	Private	2	0	-	-	1	0
Selangor & WP Putrajaya & WP KL	NGO	-	-	-	-	-	-
Selangor & WP Putrajaya & WP KL	Total	375	65	532	84	755	111
Negeri Sembilan	Public	64	72	63	66	18	18
Negeri Sembilan	Private	-	-	-	-	-	-
Negeri Sembilan	NGO	-	-	-	-	-	-
Negeri Sembilan	Total	64	72	63	66	18	18
Melaka	Public	1	2	31	43	47	61
Melaka	Private	-	-	2	3	1	1
Melaka	NGO	-	-	-	-	-	-
Melaka	Total	1	2	33	46	48	62
Johor	Public	104	36	183	59	145	44
Johor	Private	-	-	10	3	35	11
Johor	NGO	-	-	-	-	-	-
Johor	Total	104	36	193	62	180	54
Pahang	Public	8	6	37	26	80	51
Pahang	Private	-	-	-	-	-	-
Pahang	NGO	-	-	-	-	-	-
Pahang	Total	8	6	37	26	80	51
Terengganu	Public	42	46	63	64	128	122
Terengganu	Private	-	-	-	-	-	-
Terengganu	NGO	-	-	-	-	-	-
Terengganu	Total	42	46	63	64	128	122
Kelantan	Public	8	6	35	23	70	42
Kelantan	Private	-	-	-	-	-	-
Kelantan	NGO	-	-	-	-	-	-
Kelantan	Total	8	6	35	23	70	42
Sabah & WP Labuan	Public	21	8	48	15	83	25
Sabah & WP Labuan	Private	1	0	-	-	-	-
Sabah & WP Labuan	NGO	-	-	-	-	-	-
Sabah & WP Labuan	Total	22	8	48	15	83	25
Sarawak	Public	9	4	48	21	85	34
Sarawak	Private	-	-	-	-	4	2
Sarawak	NGO	-	-	-	-	-	-
Sarawak	Total	9	4	48	21	89	36

PMP = per million population

HD capacity to patient ratio has decreased over the last 10 years. This decrease was best seen in the private sector. [Figure 2.2.8(a)] There is no obvious relationship noted between the economic status of the state and the HD capacity to patient ratio.

**Table 2.2.8:** HD Capacity to Patient Ratio among HD Centres in Malaysia by State and Sector, 2001-2010

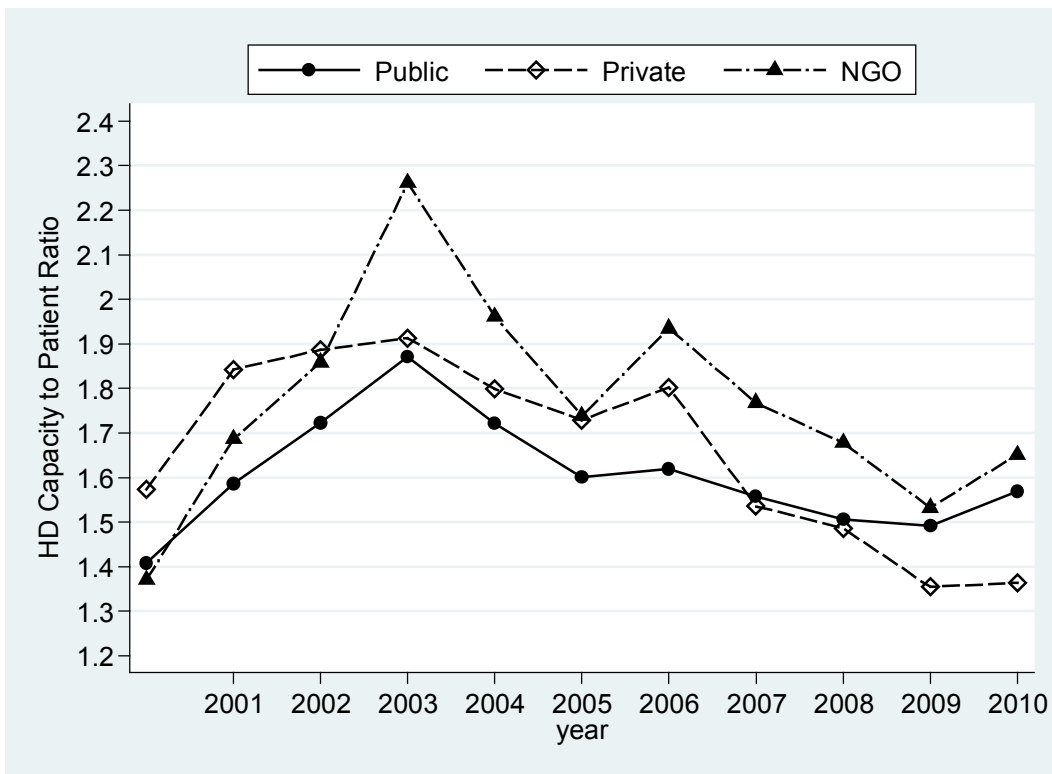
State	Sector	2001			2005			2010		
		Centre HD Capacity		HD Capacity: Patients ratio	Centre HD Capacity		HD Capacity: Patients ratio	Centre HD Capacity		HD Capacity: Patients ratio
		n (Patient)	n (Machine)		n (Patient)	n (Machine)		n (Patient)	n (Machine)	
Malaysia	Public	2042	648	1.59	3668	1174	1.6	5375	1687	1.57
Malaysia	Private	2328	858	1.84	4170	1442	1.73	9772	2665	1.36
Malaysia	NGO	2431	820	1.69	4208	1463	1.74	6492	2144	1.65
Malaysia	Total	6801	2326	1.71	12046	4079	1.69	21639	6496	1.5
Perlis	Public	50	15	1.5	88	25	1.42	86	32	1.86
Perlis	Private	-	-	-	-	-	-	-	-	-
Perlis	NGO	-	-	-	12	10	4.17	41	15	1.83
Perlis	Total	50	15	1.5	100	35	1.75	127	47	1.85
Kedah	Public	178	50	1.4	280	82	1.46	378	110	1.46
Kedah	Private	111	50	2.25	268	122	2.28	606	164	1.35
Kedah	NGO	85	27	1.59	178	63	1.77	263	81	1.54
Kedah	Total	374	127	1.7	726	267	1.84	1247	355	1.42
Kedah & Perlis	Public	228	65	1.43	368	107	1.45	464	142	1.53
Kedah & Perlis	Private	111	50	2.25	268	122	2.28	606	164	1.35
Kedah & Perlis	NGO	85	27	1.59	190	73	1.92	304	96	1.58
Kedah & Perlis	Total	424	142	1.67	826	302	1.83	1374	402	1.46
Pulau Pinang	Public	103	49	2.38	158	57	1.8	213	93	2.18
Pulau Pinang	Private	427	150	1.76	558	182	1.63	911	276	1.51
Pulau Pinang	NGO	187	79	2.11	412	143	1.74	679	249	1.83
Pulau Pinang	Total	717	278	1.94	1128	382	1.69	1803	618	1.71
Perak	Public	192	62	1.61	314	126	2.01	419	171	2.04
Perak	Private	332	141	2.12	591	188	1.59	1278	309	1.21
Perak	NGO	213	71	1.67	410	160	1.95	634	205	1.62
Perak	Total	737	274	1.86	1315	474	1.8	2331	685	1.47
Selangor & WP Putrajaya	Public	179	75	2.09	437	148	1.69	514	205	1.99
Selangor & WP Putrajaya	Private	405	151	1.86	944	302	1.6	2301	669	1.45
Selangor & WP Putrajaya	NGO	363	129	1.78	753	301	2	1093	391	1.79
Selangor & WP Putrajaya	Total	947	355	1.87	2134	751	1.76	3908	1265	1.62
WP Kuala Lumpur	Public	189	81	2.14	290	80	1.38	250	100	2
WP Kuala Lumpur	Private	459	151	1.64	660	238	1.8	1017	314	1.54
WP Kuala Lumpur	NGO	415	98	1.18	462	147	1.59	721	237	1.64
WP Kuala Lumpur	Total	1063	330	1.55	1412	465	1.65	1988	651	1.64
Selangor & WP Putrajaya & WP KL	Public	368	156	2.12	727	228	1.57	764	305	2
Selangor & WP Putrajaya & WP KL	Private	864	302	1.75	1604	540	1.68	3318	983	1.48
Selangor & WP Putrajaya & WP KL	NGO	778	227	1.46	1215	448	1.84	1814	628	1.73
Selangor & WP Putrajaya & WP KL	Total	2010	685	1.7	3546	1216	1.71	5896	1916	1.62

**Table 2.2.8:** HD Capacity to Patient Ratio among HD Centres in Malaysia by State and Sector, 2001-2010 (cont'd.)

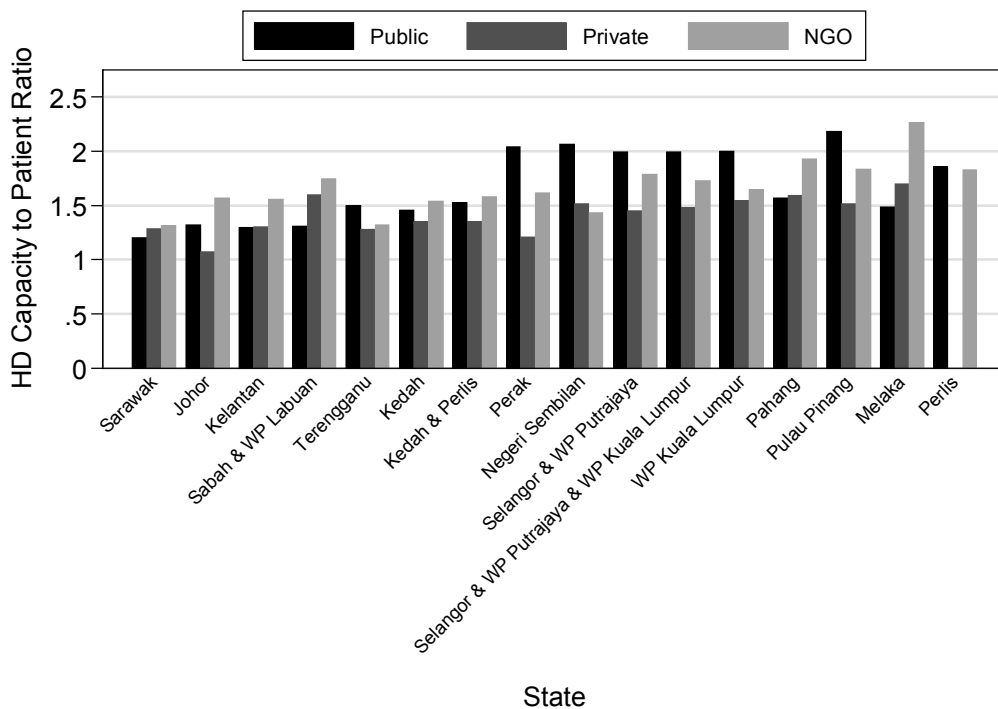
State	Sector	2001			2005			2010		
		Centre HD Capacity		HD Capacity: Patients ratio	Centre HD Capacity		HD Capacity: Patients ratio	Centre HD Capacity		HD Capacity: Patients ratio
		n (Patient)	n (Machine)		n (Patient)	n (Machine)		n (Patient)	n (Machine)	
Negeri Sembilan	Public	82	23	1.4	159	43	1.35	189	78	2.06
Negeri Sembilan	Private	12	10	4.17	53	14	1.32	287	87	1.52
Negeri Sembilan	NGO	148	48	1.62	365	79	1.08	519	149	1.44
Negeri Sembilan	Total	242	81	1.67	577	136	1.18	995	314	1.58
Melaka	Public	71	22	1.55	97	29	1.49	128	38	1.48
Melaka	Private	113	48	2.12	219	76	1.74	454	154	1.7
Melaka	NGO	186	77	2.07	237	86	1.81	223	101	2.26
Melaka	Total	370	147	1.99	553	191	1.73	805	293	1.82
Johor	Public	252	64	1.27	438	121	1.38	612	162	1.32
Johor	Private	258	82	1.59	534	192	1.8	1884	405	1.07
Johor	NGO	593	198	1.67	928	314	1.69	1268	398	1.57
Johor	Total	1103	344	1.56	1900	627	1.65	3764	965	1.28
Pahang	Public	102	26	1.27	240	93	1.94	452	142	1.57
Pahang	Private	38	8	1.05	39	16	2.05	210	67	1.6
Pahang	NGO	46	18	1.96	75	32	2.13	202	78	1.93
Pahang	Total	186	52	1.4	354	141	1.99	864	287	1.66
Terengganu	Public	96	30	1.56	206	53	1.29	317	95	1.5
Terengganu	Private	-	-	-	17	7	2.06	117	30	1.28
Terengganu	NGO	32	12	1.88	48	19	1.98	125	33	1.32
Terengganu	Total	128	42	1.64	271	79	1.46	559	158	1.41
Kelantan	Public	93	39	2.1	228	67	1.47	354	92	1.3
Kelantan	Private	44	24	2.73	100	40	2	238	62	1.3
Kelantan	NGO	20	10	2.5	36	10	1.39	77	24	1.56
Kelantan	Total	157	73	2.32	364	117	1.61	669	178	1.33
Sabah & WP Labuan	Public	245	57	1.16	396	143	1.81	815	213	1.31
Sabah & WP Labuan	Private	3	5	8.33	13	9	3.46	119	38	1.6
Sabah & WP Labuan	NGO	30	16	2.67	74	28	1.89	146	51	1.75
Sabah & WP Labuan	Total	278	78	1.4	483	180	1.86	1080	302	1.4
Sarawak	Public	210	55	1.31	337	107	1.59	648	156	1.2
Sarawak	Private	126	38	1.51	174	56	1.61	350	90	1.29
Sarawak	NGO	113	37	1.64	218	71	1.63	501	132	1.32
Sarawak	Total	449	130	1.45	729	234	1.6	1499	378	1.26

PMP = per million population

**Figure 2.2.8(a):** HD Capacity to Patient Ratio among HD Centres in Malaysia, 2001-2010



**Figure 2.2.8(b):** HD Capacity to Patient Ratio among HD Centres in Malaysia by State and sector 2010



## 2.2.2: Manpower in Dialysis Centres

The number of registered dialysis nurses/medical technicians in Malaysia increased from 966 (40 per million population) in 2001 to 2138 (76 pmp) in 2010. However, this increase was mainly seen in the public and private sector [Figure 2.2.9(a)]. Overall, the public sector had consistently higher dialysis technician/nurse to population ratio followed by the private sector. Despite its gradual improvement, the NGO sector continue to have the lowest dialysis staff to population ratio compared to the other two sectors.

In contrast to the national average, the private dialysis centres in Pulau Pinang, Perak, Selangor and Kuala Lumpur, Melaka and Johor had the highest dialysis staff to population ratio. These are the states where at least half of HD patients were found in private centres.

**Table 2.2.9:** Number & density of Registered Dialysis Nurses/ Medical technicians in Malaysia by State and Sector, 2001-2010

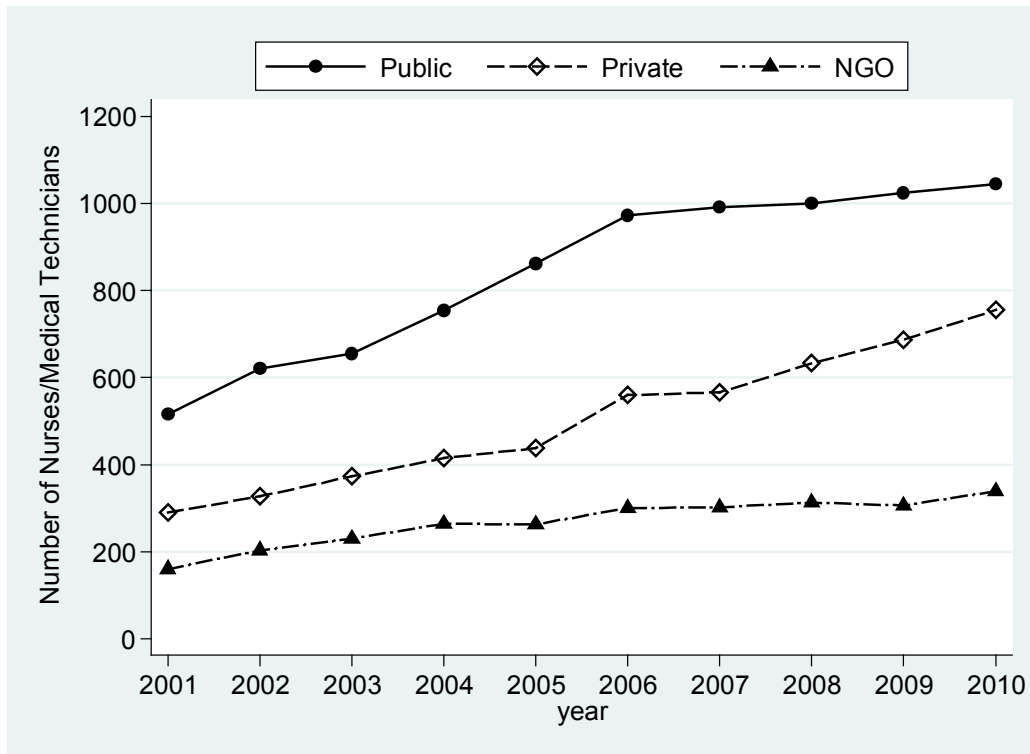
State	Sector	2001		2005		2010	
		n	pmp	n	pmp	n	pmp
Malaysia	Public	516	0.21	862	0.33	1044	0.37
Malaysia	Private	290	0.12	438	0.17	755	0.27
Malaysia	NGO	160	0.07	263	0.1	339	0.12
Malaysia	Total	966	0.4	1563	0.59	2138	0.76
Perlis	Public	10	0.47	12	0.53	11	0.46
Perlis	Private	-	-	-	-	-	-
Perlis	NGO	-	-	4	0.18	6	0.25
Perlis	Total	10	0.47	16	0.71	17	0.71
Kedah	Public	51	0.3	61	0.33	70	0.36
Kedah	Private	20	0.12	36	0.2	53	0.27
Kedah	NGO	8	0.05	12	0.07	13	0.07
Kedah	Total	79	0.46	109	0.59	136	0.69
Kedah & Perlis	Public	61	0.32	73	0.35	81	0.37
Kedah & Perlis	Private	20	0.1	36	0.17	53	0.24
Kedah & Perlis	NGO	8	0.04	16	0.08	19	0.09
Kedah & Perlis	Total	89	0.46	125	0.6	153	0.69
Pulau Pinang	Public	31	0.23	50	0.33	67	0.42
Pulau Pinang	Private	50	0.36	60	0.4	88	0.55
Pulau Pinang	NGO	20	0.15	34	0.23	54	0.34
Pulau Pinang	Total	101	0.74	144	0.96	209	1.32
Perak	Public	39	0.18	82	0.36	90	0.37
Perak	Private	33	0.15	42	0.18	59	0.24
Perak	NGO	10	0.05	16	0.07	23	0.09
Perak	Total	82	0.38	140	0.61	172	0.7
Selangor & WP Putrajaya	Public	61	0.14	86	0.18	115	0.23
Selangor & WP Putrajaya	Private	66	0.15	110	0.23	230	0.45
Selangor & WP Putrajaya	NGO	30	0.07	65	0.14	75	0.15
Selangor & WP Putrajaya	Total	157	0.36	261	0.55	420	0.82
WP Kuala Lumpur	Public	75	0.51	74	0.46	77	0.45
WP Kuala Lumpur	Private	48	0.33	62	0.38	69	0.4
WP Kuala Lumpur	NGO	16	0.11	22	0.14	36	0.21
WP Kuala Lumpur	Total	139	0.95	158	0.98	182	1.06
Selangor & WP Putrajaya & WP KL	Public	136	0.24	160	0.25	192	0.28
Selangor & WP Putrajaya & WP KL	Private	114	0.2	172	0.27	299	0.44
Selangor & WP Putrajaya & WP KL	NGO	46	0.08	87	0.14	111	0.16
Selangor & WP Putrajaya & WP KL	Total	296	0.51	419	0.66	602	0.88



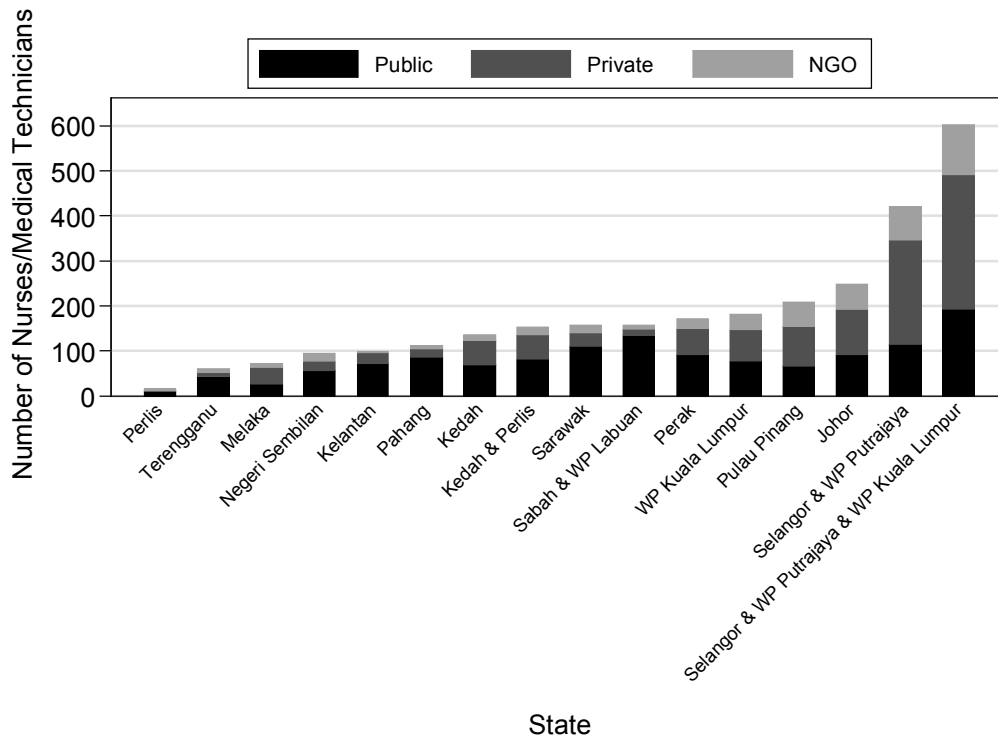
**Table 2.2.9:** Number & density of Registered Dialysis Nurses/ Medical technicians in Malaysia by State and Sector, 2001-2010 (cont'd.)

State	Sector	2001		2005		2010	
		n	pmp	n	pmp	n	pmp
Negeri Sembilan	Public	15	0.17	32	0.33	57	0.56
Negeri Sembilan	Private	6	0.07	5	0.05	20	0.2
Negeri Sembilan	NGO	8	0.09	13	0.14	18	0.18
Negeri Sembilan	Total	29	0.33	50	0.52	95	0.94
Melaka	Public	15	0.23	21	0.29	25	0.32
Melaka	Private	18	0.27	27	0.37	38	0.49
Melaka	NGO	11	0.17	13	0.18	9	0.12
Melaka	Total	44	0.66	61	0.84	72	0.93
Johor	Public	42	0.15	75	0.24	90	0.27
Johor	Private	25	0.09	52	0.17	102	0.31
Johor	NGO	34	0.12	50	0.16	56	0.17
Johor	Total	101	0.35	177	0.57	248	0.75
Pahang	Public	25	0.19	57	0.39	85	0.55
Pahang	Private	3	0.02	5	0.03	20	0.13
Pahang	NGO	4	0.03	7	0.05	7	0.05
Pahang	Total	32	0.24	69	0.48	112	0.72
Terengganu	Public	32	0.35	39	0.4	42	0.4
Terengganu	Private	-	-	4	0.04	10	0.1
Terengganu	NGO	3	0.03	5	0.05	9	0.09
Terengganu	Total	35	0.38	48	0.49	61	0.58
Kelantan	Public	35	0.25	64	0.42	72	0.43
Kelantan	Private	5	0.04	12	0.08	23	0.14
Kelantan	NGO	3	0.02	3	0.02	4	0.02
Kelantan	Total	43	0.31	79	0.52	99	0.59
Sabah & WP Labuan	Public	43	0.16	116	0.37	133	0.4
Sabah & WP Labuan	Private	5	0.02	8	0.03	14	0.04
Sabah & WP Labuan	NGO	5	0.02	8	0.03	11	0.03
Sabah & WP Labuan	Total	53	0.19	132	0.42	158	0.48
Sarawak	Public	42	0.2	93	0.4	110	0.44
Sarawak	Private	11	0.05	15	0.06	29	0.12
Sarawak	NGO	8	0.04	11	0.05	18	0.07
Sarawak	Total	61	0.29	119	0.51	157	0.63

**Figure 2.2.9(a):** Number of Registered Dialysis Nurses/ Medical technicians in Malaysia by Sector from 2001-2010



**Figure 2.2.9(b):** Number of Registered Dialysis Nurses/ Medical technicians in Malaysia by State and Sector in 2010



## SECTION 2.3: DISTRIBUTION OF DIALYSIS TREATMENT

### 2.3.1: Gender distribution

The treatment gap between men and women accepted for dialysis has remained consistent over the years, suggesting this is a true reflection of the difference in ESRD incidence between genders. Since 2001, the male to female prevalent dialysis patients remained the same at 55 to 45% respectively. However the ratio between males and females was slightly higher in the incident patients compared to prevalent patients suggesting a very small survival advantage in female patients on dialysis.

**Table 2.3.1(a):** Dialysis Treatment Rate by Gender, per million male or female population 2001-2010

Gender	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Male	97	110	122	128	139	155	170	191	198	188
Female	88	94	95	110	111	133	143	157	163	154

**Figure 2.3.1(a) :** Dialysis Treatment Rate by Gender 2001-2010

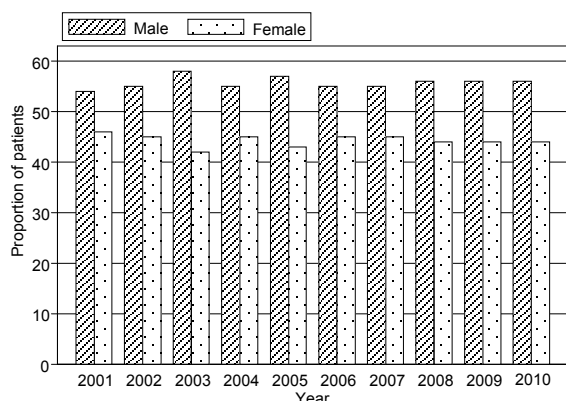


**Table 2.3.1(b):** Gender Distribution of Dialysis Patients 2001-2010

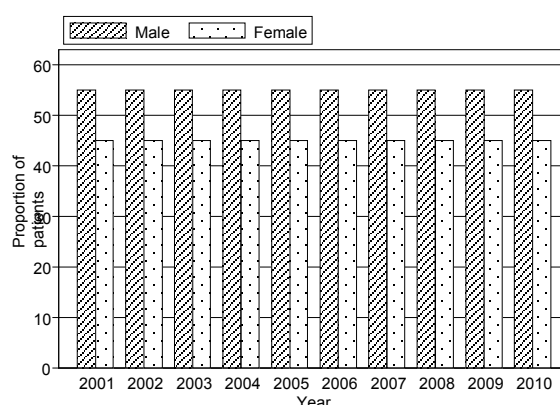
Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
New Dialysis patients	2112	2373	2620	2891	3134	3669	4047	4548	4740	4521
% Male	54	55	58	55	57	55	55	56	56	56
% Female	46	45	42	45	43	45	45	44	44	44
Dialysing at 31 <sup>st</sup> December	7837	9102	10399	11829	13332	15046	17022	19250	21245	22932
% Male	55	55	55	55	55	55	55	55	55	55
% Female	45	45	45	45	45	45	45	45	45	45

**Figure 2.3.1(b):** Gender Distribution of Dialysis Patients 2001-2010

(i) New Dialysis patients



(ii) Dialysing patients at 31<sup>st</sup> December



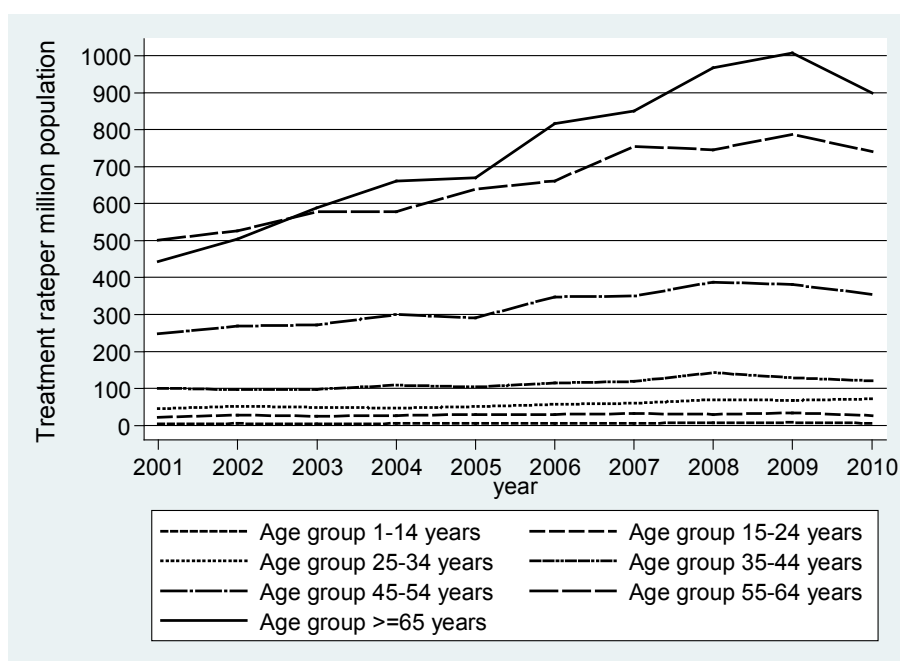
### 2.3.2: Age distribution

New dialysis treatment rates in the younger age-groups less than 55 years have remained unchanged in the last few years, suggesting that almost all patients with ESRD in those age groups who were in need of dialysis were able to access treatment. The treatment rate for patients 65 years and older have continued to show rapid increase to more than 1000 per million age related population in 2009 (Table 2.3.2 (a)). 55% of new dialysis patients were at least 55 years old at the onset of dialysis.

**Table 2.3.2(a):** Dialysis Treatment Rate by Age Group, per million age group population 2001-2010

Age groups (years)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
≤14	4	5	4	5	6	5	6	7	8	6
15-24	22	28	25	27	30	30	32	30	34	27
25-34	45	52	49	47	51	57	60	70	68	72
35-44	101	97	98	109	104	115	119	143	129	121
45-54	248	269	272	300	291	348	350	388	381	355
55-64	502	527	578	579	639	662	755	746	787	741
≥ 65	444	505	588	661	670	816	851	967	1007	899

**Figure 2.3.2(a):** Dialysis Treatment Rate by Age Group 2001-2010



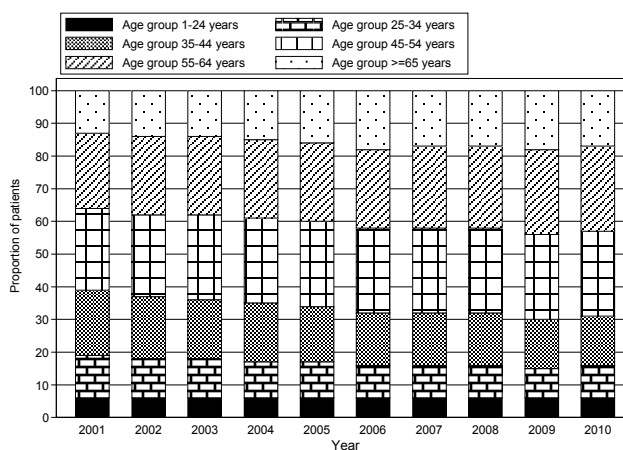
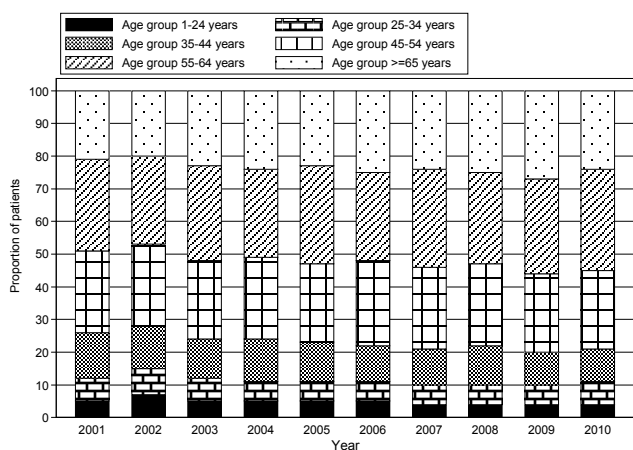
**Table 2.3.2:** Percentage Age Distribution of Dialysis Patients 2001-2010

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
New Dialysis patients	2112	2373	2620	2891	3134	3669	4047	4548	4740	4521
% 1-14 years	1	2	1	1	1	1	1	1	1	1
% 15-24 years	4	5	4	4	4	4	3	3	3	3
% 25-34 years	7	8	7	6	6	6	6	6	6	7
% 35-44 years	14	13	12	13	12	11	11	12	10	10
% 45-54 years	25	25	24	25	24	26	25	25	24	24
% 55-64 years	28	27	29	27	30	27	30	28	29	31
% ≥65 years	21	20	23	24	23	25	24	25	27	24
Dialysing at 31 <sup>st</sup> December	7837	9102	10399	11829	13332	15046	17022	19250	21245	22932
% 1-14 years	1	1	1	1	1	1	1	1	1	1
% 15-24 years	5	5	5	5	5	5	5	5	5	5
% 25-34 years	13	12	12	11	11	10	10	10	9	10
% 35-44 years	20	19	18	18	17	16	16	16	15	15
% 45-54 years	25	25	26	26	26	26	26	26	26	26
% 55-64 years	23	24	24	24	24	24	25	25	26	26
% ≥65 years	13	14	14	15	16	18	17	17	18	17

**Figure 2.3.2(b):** Age Distribution of New Dialysis Patients 2001-2010

(i) New Dialysis Patients

(ii) Dialysing patients at 31<sup>st</sup> December



### 2.3.3: Method and Location of dialysis

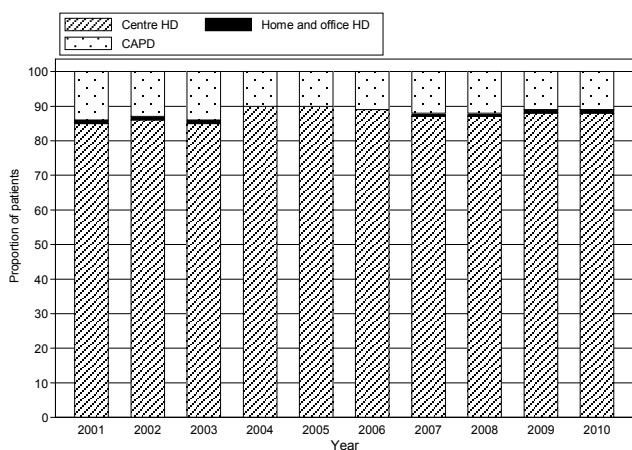
88% of new patients were accepted into centre haemodialysis program in 2009/2010. Despite the conscious effort by the Ministry of Health to utilize PD first, the proportion of new patients accepted into chronic PD program has remained about 11-12% and only accounted for 8% of prevalent dialysis patients. This is due to a small number of PD patients in the private sector and none in the NGO sector. There were still a handful of new patients accepted into the home and office HD programme. (Table & Figure 2.3.5)

**Table 2.3.3:** Method and Location of Dialysis Patients 2001-2010

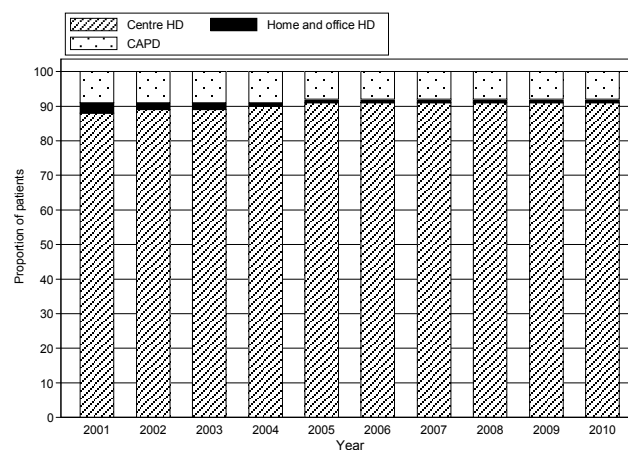
Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
New Dialysis patients	2112	2373	2620	2891	3134	3669	4047	4548	4740	4521
% Centre HD	85	86	85	90	90	89	87	87	88	88
% Home and office HD	1	1	1	0	0	0	1	1	1	1
% PD	14	13	14	10	10	11	12	12	11	11
Dialysing at 31 <sup>st</sup> December	7489	8687	9943	11272	12697	14328	16217	18326	20233	21797
% Centre HD	88	89	89	90	91	91	91	91	91	91
% Home and office HD	3	2	2	1	1	1	1	1	1	1
% PD	9	9	9	9	8	8	8	8	8	8

**Figure 2.3.3:** Method and Location of Dialysis Patients 2001-2010

(i) New Dialysis Patients



(ii) Dialysing patients at 31<sup>st</sup> December



**2.3.4: Funding for Dialysis Treatment**

In Malaysia, there are multiple sources of funding for dialysis. In the initial years of the registry, data for funding of dialysis treatment were obtained mainly from the initial notification of the patient. In 2006, data on funding was included in the annual returns as it was noted that funding for dialysis treatment in an individual patient can change with time.

The government continues to be the main payer for dialysis therapy for new and existing patients. These funds are channeled not only to the government dialysis centres but also as subsidies to NGO centres and payment of dialysis treatment for civil servants and their dependents in private centres. Out of pocket payment ie self-funding for dialysis was about 22 to 25%. Funding from NGO bodies has declined over the years. (Table & Figure 2.3.4)

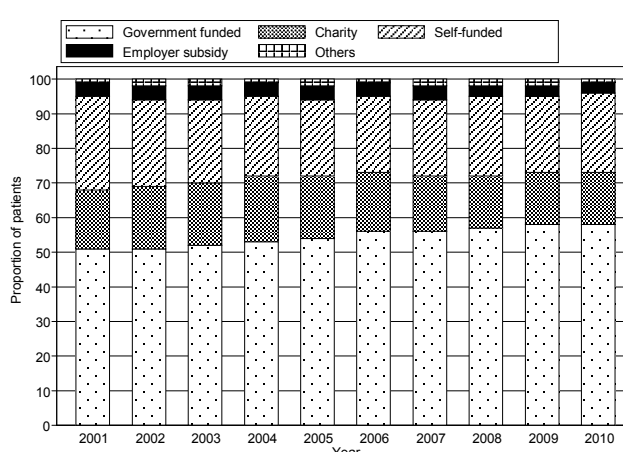
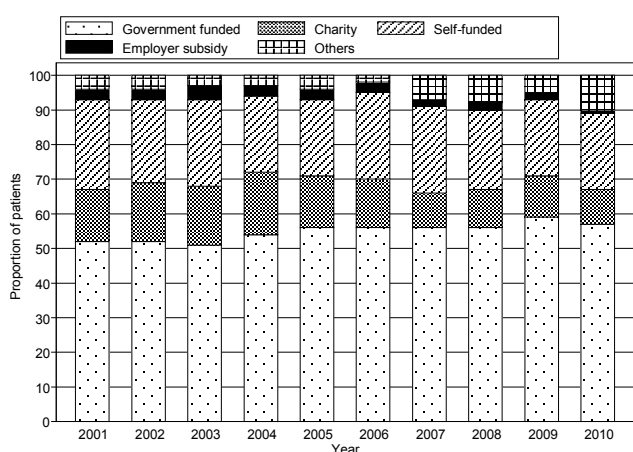
**Table 2.3.4: Funding for Dialysis Treatment 2001-2010**

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
New Dialysis patients	2112	2373	2620	2891	3134	3669	4047	4548	4740	4521
% by Government	52	52	51	54	56	56	56	56	59	57
% by Charity	15	17	17	18	15	14	10	11	12	10
% self funded	26	24	25	22	22	25	25	23	22	22
% subsidized by Employer	3	3	4	3	3	3	2	2	2	1
% Others	4	4	3	3	4	2	7	8	5	10
Dialysing at 31 <sup>st</sup> December	7489	8687	9943	11272	12697	14328	16217	18326	20233	21797
% by Government	51	51	52	53	54	56	56	57	58	58
% by Charity	17	18	18	19	18	17	16	15	15	15
% self funded	27	25	24	23	22	22	22	23	22	23
% subsidized by Employer	4	4	4	4	4	4	4	3	3	3
% Others	1	2	2	1	2	1	2	2	2	1

**Figure 2.3.4: Funding for Dialysis Treatment 2001-2010**

(i) New Dialysis Patients

(ii) Dialysing patients at 31<sup>st</sup> December



### 2.3.5: Distribution of dialysis patients by sector

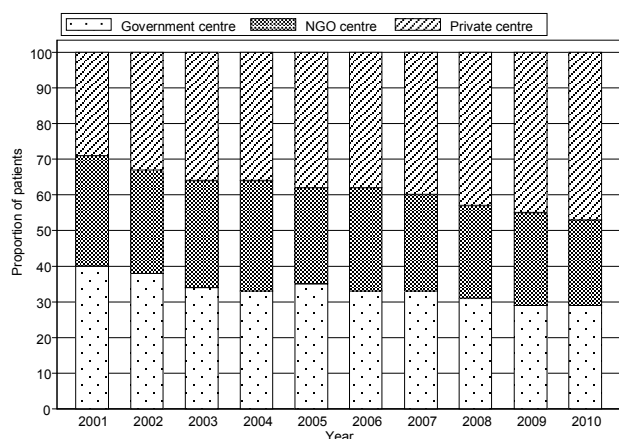
The proportion of new dialysis patients accepted into private dialysis centres continue to increase while that in MOH and NGO centres seem to show a decrease. Since 2008 the private sector is the largest provider of dialysis.

**Table 2.3.5:** Distribution of Dialysis Patients by Sector 2001-2010

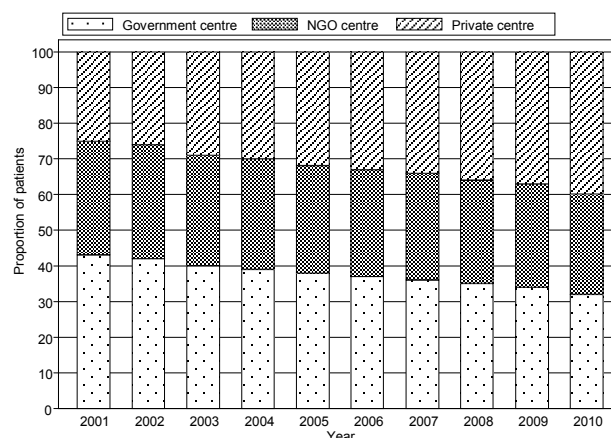
Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
New Dialysis patients	2112	2373	2620	2891	3134	3669	4047	4548	4740	4521
% Government centre	40	38	34	33	35	33	33	31	29	29
% NGO centre	31	29	30	31	27	29	27	26	26	24
% Private centre	29	33	36	36	38	38	40	43	45	47
Dialysing at 31 <sup>st</sup> December	7837	9102	10399	11829	13332	15046	17022	19250	21245	22932
% Government centre	43	42	40	39	38	37	36	35	34	32
% NGO centre	32	32	31	31	30	30	30	29	29	28
% Private centre	25	26	29	30	32	33	34	36	37	40

**Figure 2.3.5:** Distribution of Dialysis Patients by Sector 2001-2010

#### (i) New Dialysis Patients



#### (ii) Dialysing patients at 31<sup>st</sup> December





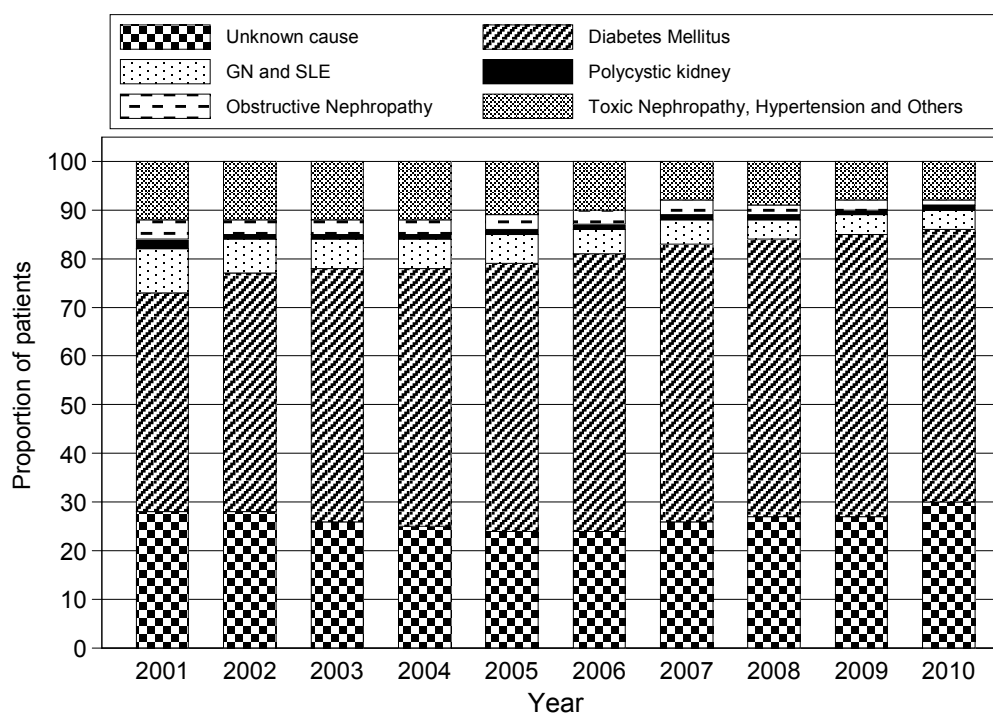
## SECTION 2.4: PRIMARY RENAL DISEASE

Diabetes mellitus accounted for more than half of the primary renal disease of new dialysis patients since 2003. Glomerulonephritis was reported as the primary renal disease in only 3% of new patients. SLE on its own accounted for 1% of all new dialysis patients. The percentage of patients with unknown primary renal disease remains high despite the increase in the number of nephrologists.

**Table 2.4.1:** Primary Renal Diseases 2001-2010

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
New Dialysis patients	2112	2373	2620	2891	3134	3669	4047	4548	4740	4521
% Unknown cause	28	28	26	25	24	24	26	27	27	30
% Diabetes Mellitus	45	49	52	53	55	57	57	57	58	56
% GN	7	6	5	5	5	4	4	3	3	3
% SLE	2	1	1	1	1	1	1	1	1	1
% Polycystic kidney	2	1	1	1	1	1	1	1	1	1
% Obstructive Nephropathy	4	3	3	3	3	3	3	2	2	1
% Toxic Nephropathy	1	0	0	0	0	0	0	0	0	0
% Hypertension	10	9	9	10	9	8	8	8	7	8
% Others	1	3	3	2	2	2	0	1	1	0

**Figure 2.4.1:** Primary Renal Diseases for New Dialysis Patients 2001-2010



CHAPTER 3

**DEATH AND SURVIVAL  
ON DIALYSIS**

Wong Hin Seng  
Ong Loke Meng

## SECTION 3.1: DEATH ON DIALYSIS

The annual death rate on dialysis in 2010 was 11.6%. The annual death rate for haemodialysis patients was 11.2% while chronic peritoneal dialysis patients had annual death rate of 16.6%.

**Table 3.1.1:** Deaths on Dialysis 2001-2010

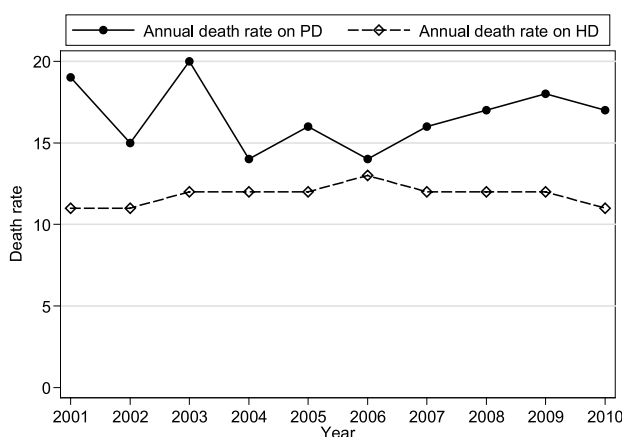
Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Number of dialysis patients at risk	7270	8470	9751	11114	12581	14189	16034	18136	20248	22089
Dialysis deaths	850	959	1211	1318	1513	1815	1984	2190	2578	2574
Dialysis death rate %	12	11	12	12	12	13	12	12	13	12
Number of HD patients at risk	6549	7619	8757	10021	11435	12948	14605	16492	18440	20176
HD deaths	711	831	1016	1162	1331	1638	1754	1913	2258	2257
HD death rate %	11	11	12	12	12	13	12	12	12	11
Number of PD patients at risk	721	851	994	1093	1146	1242	1429	1645	1808	1913
PD deaths	139	128	195	156	182	177	230	277	320	317
PD death rate %	19	15	20	14	16	14	16	17	18	17

Figure 3.1.1 shows the annual death rate on dialysis from 2000 till 2010. Despite a higher percentage of diabetics and elderly patients on dialysis in recent years, the overall annual death rate of patients on dialysis remained unchanged over the last 10 years.

The annual death rate for those on chronic peritoneal dialysis (PD) appeared to be on an upward trend since 2006 while the annual death rate for those on haemodialysis remained unchanged over the last 10 years (11-12%). This resulted in widening of the difference in mortality rate between the two modalities. The difference in annual death rate for those on PD compared with HD increased from 1% in 2006 to 5.4% in 2010.

The causes of death on dialysis are shown in Table 3.1.2. Cardiovascular disease remained the main cause of death in 2010; accounting for 34%. Death due to cardiovascular disease appeared to be an increasing in the last 6 years and this is probably due to the increasing number of elderly and diabetic patients undergoing dialysis. Death at home accounted for another 20% and a majority of these deaths were probably due to cardiovascular events. Death from infection has increased over the last 4 years and has now become the second most common cause of death in 2010; accounting for 24% of all death.

**Figure 3.1.1:** Death Rates on Dialysis 2001-2010



**Table 3.1.2:** Causes of Death on Dialysis 2001-2010

Year Causes of Death	2001		2002		2003		2004		2005	
	n	%	n	%	n	%	n	%	n	%
Cardiovascular	221	26	313	33	341	28	341	26	376	25
Died at home	228	27	212	22	290	24	307	23	320	21
Sepsis	134	16	148	15	197	16	166	13	179	12
PD peritonitis	30	4	16	2	14	1	13	1	22	1
GIT bleed	18	2	24	3	29	2	24	2	29	2
Cancer	18	2	18	2	28	2	20	2	28	2
Liver disease	11	1	16	2	25	2	29	2	26	2
Withdrawal	20	2	18	2	26	2	9	1	11	1
Others	89	10	104	11	161	13	325	25	406	27
Unknown	81	10	90	9	100	8	84	6	116	8
TOTAL	850	100	959	100	1211	100	1318	100	1513	100

**Table 3.1.2:** Causes of Death on Dialysis 2001-2010 (cont'd.)

Year Causes of Death	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
Cardiovascular	517	28	516	26	682	31	871	34	871	34
Died at home	354	20	343	17	423	19	492	19	507	20
Sepsis	235	13	222	11	336	15	570	22	605	24
PD peritonitis	22	1	16	1	25	1	30	1	34	1
GIT bleed	26	1	31	2	43	2	44	2	51	2
Cancer	41	2	34	2	53	2	54	2	69	3
Liver disease	35	2	37	2	44	2	26	1	31	1
Withdrawal	23	1	27	1	24	1	34	1	29	1
Others	392	22	552	28	366	17	195	8	108	4
Unknown	170	9	206	10	194	9	262	10	269	10
TOTAL	1815	100	1984	100	2190	100	2578	100	2574	100

## SECTION 3.2: PATIENT SURVIVAL ON DIALYSIS

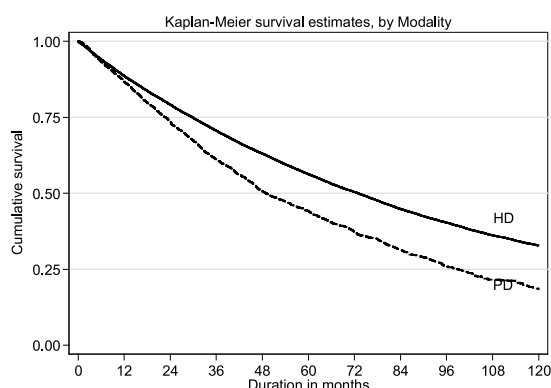
### 3.2.1: Patient survival by type of dialysis modality

Patient survival by first dialysis modalities (censored for change of modalities) is shown in Table 3.2.1(a) and Figure 3.2.1(a). The overall unadjusted 5 years and 10 years patient survival on dialysis (censored for change in modality) were 55% and 32% respectively. The unadjusted patient survival was better for those on haemodialysis compared to those on PD and this survival difference began to widen after the first year. At 10 years the unadjusted patient survival on haemodialysis was 33% compared 18% in those on PD; a 15% difference in 10-year survival.

However, when patient survival by dialysis modalities was analysed as per ITT (disregarding change of dialysis modality) [Table 3.2.1(b) and Figure 3.2.1(b)], the difference in survival according to dialysis modalities is less apparent. The overall unadjusted 5 years and 10 years patient survival on haemodialysis versus PD were 57% vs 48% and 35% and 28% respectively.

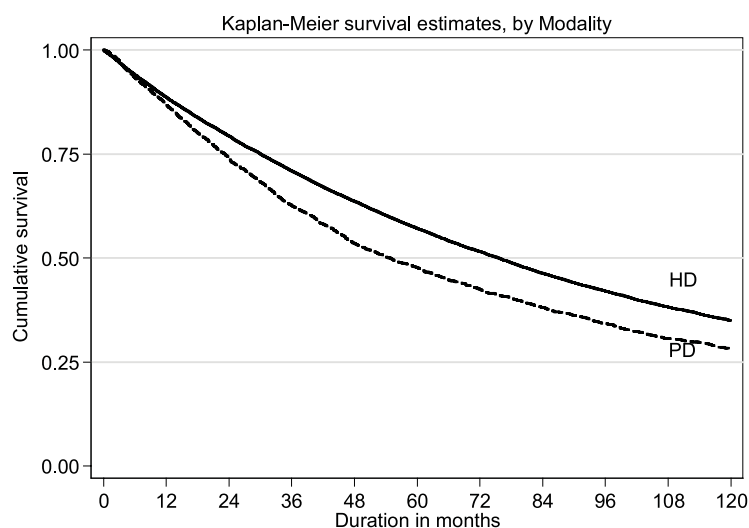
**Table 3.2.1 (a):** Patient survival by dialysis modality analysis (censored for change of modality)

Dialysis Modality Interval (month)	PD			HD			All		
	n	% survival	SE	n	% survival	SE	n	% survival	SE
0	5705	100		39368	100		45073	100	
6	4899	93	0	34744	94	0	39643	94	0
12	4090	87	0	30262	89	0	34352	88	0
24	2760	74	1	23279	79	0	26039	79	0
36	1812	61	1	17929	71	0	19741	70	0
48	1172	51	1	13649	63	0	14821	62	0
60	802	44	1	10337	56	0	11139	55	0
72	542	37	1	7932	50	0	8473	49	0
84	342	31	1	5989	45	0	6330	43	0
96	202	26	1	4588	40	0	4787	39	0
108	126	22	1	3456	36	0	3581	35	0
120	73	18	1	2632	33	0	2705	32	0

**Figure 3.2.1(a):** Patient survival by dialysis modality analysis (censored for change of modality)

**Table 3.2.1(b):** Patient survival by dialysis modality analysis (not censored for change of modality)

Dialysis modality Interval (month)	PD			HD			All		
	n	% survival	SE	n	% survival	SE	N	% survival	SE
0	5705	100		39368	100		45073	100	
6	5083	93	0	35268	94	0	40351	94	0
12	4470	87	0	31171	89	0	35641	88	0
24	3370	74	1	24544	79	0	27902	79	0
36	2520	63	1	19261	71	0	21781	70	0
48	1883	54	1	14964	64	0	16847	62	0
60	1504	48	1	11616	57	0	13120	56	0
72	1209	43	1	9122	52	0	10330	50	0
84	965	38	1	7085	46	0	8049	45	0
96	751	34	1	5579	42	0	6328	41	0
108	565	31	1	4340	38	0	4904	37	0
120	429	28	1	3426	35	0	3855	34	0

**Figure 3.2.1(b):** Patient survival by dialysis modality analysis (not censored for change of modality)

### 3.2.2: Patient survival by year of starting dialysis

Table 3.2.2 and Figure 3.2.2 show the unadjusted patient survival by year of entry. The unadjusted 6 months survival of those starting dialysis in 2010 was 93%. Despite a progressive increase in the number of diabetic patients and older people starting dialysis in recent years, the unadjusted patient survival remained constant over the last 10 years with a 1-year and 5-year survival of 87-89% and 53-54% respectively.

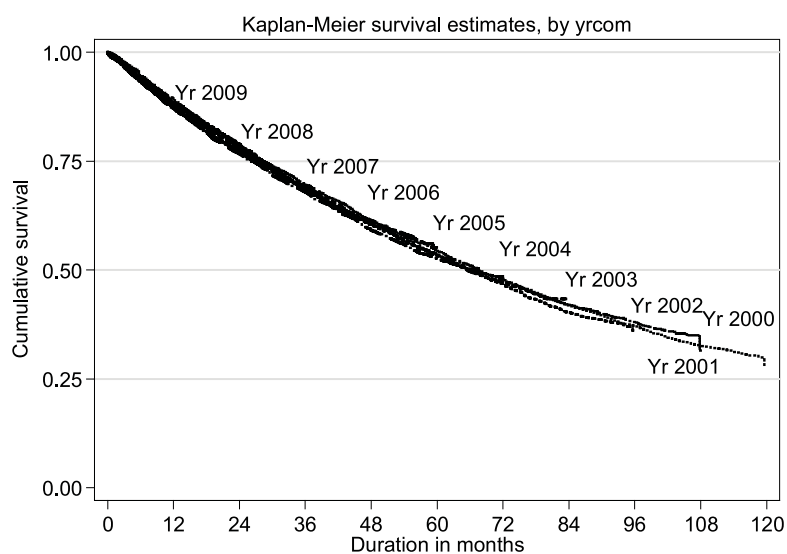
**Table 3.2.2:** Unadjusted patient survival by year of entry, 2001-2010

Year Interval (month)	2001			2002			2003			2004		
	n	% survival	SE	n	% survival	SE	n	% survival	SE	n	% survival	SE
0	2238	100		2522	100		2759	100		3086	100	
6	2073	94	1	2359	95	0	2542	94	0	2874	94	0
12	1892	89	1	2179	89	1	2337	88	1	2642	88	1
24	1601	78	1	1841	79	1	2009	78	1	2286	79	1
36	1383	69	1	1595	70	1	1716	68	1	1955	69	1
48	1193	61	1	1383	61	1	1489	60	1	1693	60	1
60	1023	54	1	1195	54	1	1292	53	1	1465	53	1
72	895	47	1	1037	48	1	1119	47	1	1273	47	1
84	781	42	1	882	42	1	945	40	1	2	-	-
96	679	37	1	783	38	1	8	-	-	-	-	-
108	595	33	1	2	-	-	-	-	-	-	-	-
120	1	-	-	-	-	-	-	-	-	-	-	-

**Table 3.2.2:** Unadjusted patient survival by year of entry, 2001-2010 (cont'd)

Year Interval (month)	2005			2006			2007			2008		
	n	% survival	SE	n	% survival	SE	n	% survival	SE	n	% survival	SE
0	3316	100		3875	100		4259	100		4803	100	
6	3047	93	0	3558	93	0	3958	94	0	4451	94	0
12	2796	87	1	3279	87	1	3654	88	1	4106	88	0
24	2399	77	1	2829	77	1	3153	78	1	3495	77	1
36	2077	68	1	2454	68	1	2723	69	1	106	-	-
48	1783	59	1	2162	61	1	43	-	-	-	-	-
60	1548	53	1	42	-	-	-	-	-	-	-	-
72	17	-	-	-	-	-	-	-	-	-	-	-

Year Interval (month)	2009			2010		
	n	% survival	SE	n	% survival	SE
0	5042	100		4840	100	
6	4667	94	0	2532	93	0
12	4301	88	0	86	-	-
24	104	-	-	-	-	-

**Figure 3.2.2:** Unadjusted patient survival by year of entry, 2001-2010

### 3.2.3: Patient survival by Age at starting dialysis

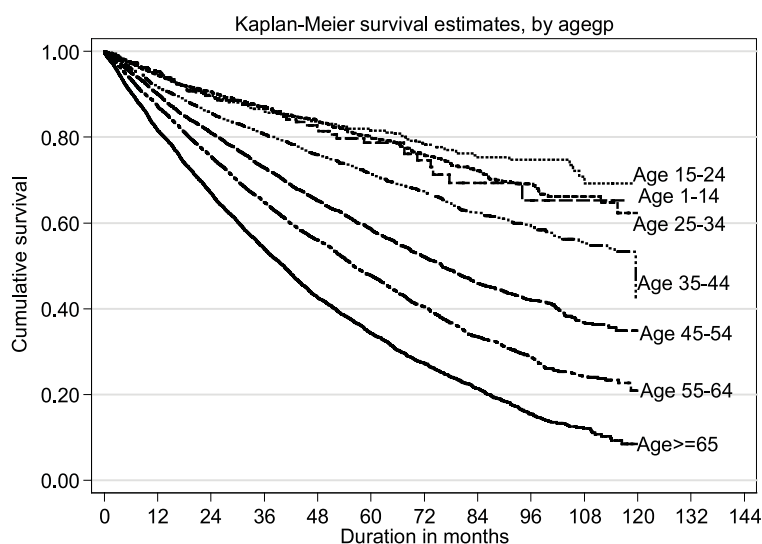
The unadjusted survival for patients starting dialysis at aged less than 35yrs was approximately 80% (79-82%) at 5 years. Beyond the age of 34 years old, the unadjusted survival progressively worsens with increasing age; with approximately 10% reduction in survival at 5 years for every 10 years increase in age at starting dialysis. The 9-year unadjusted survival for those who started dialysis at the age of 15-24 years was 71 % compared with 12% in those aged more than 64 years at the time of initiation of dialysis; a six fold difference.

**Table 3.2.3:** Unadjusted patient survival by age, 2001-2010

Age group (years) Interval (month)	<15			15-24			25-34			35-44		
	n	% survival	SE	n	% survival	SE	n	% survival	SE	n	% survival	SE
0	434	100	-	1417	100		2522	100	-	4318	100	-
6	396	97	1	1271	97	0	2237	97	0	3847	96	0
12	340	95	1	1117	95	1	1924	94	0	3341	92	0
24	247	89	2	828	90	1	1479	91	1	2577	86	1
36	163	87	2	647	86	1	1148	87	1	1962	81	1
48	114	82	2	489	83	1	870	84	1	1498	76	1
60	74	79	3	359	82	1	634	80	1	1089	71	1
72	51	75	4	263	79	2	467	76	1	801	67	1
84	27	69	4	169	75	2	317	72	1	511	62	1
96	17	65	6	101	75	2	184	69	2	327	59	1
108	7	65	6	47	71	3	69	66	2	147	55	2
120	1	-	-	1	-	-	1	-	-	2	-	-

Age group (years) Interval (month)	45-54			55-64			≥65		
	n	% survival	SE	n	% survival	SE	n	% survival	SE
0	8995	100	-	10442	100	-	8612	100	-
6	7992	95	0	9063	94	0	7251	90	0
12	6845	90	0	7664	87	0	5957	82	0
24	5086	81	0	5424	76	0	3967	67	1
36	3731	73	1	3781	65	1	2577	54	1
48	2653	65	1	2536	56	1	1572	43	1
60	1798	59	1	1629	48	1	942	34	1
72	1184	52	1	1006	40	1	559	27	1
84	733	46	1	564	34	1	294	21	1
96	429	42	1	281	29	1	125	15	1
108	180	37	1	106	24	1	43	12	1
120	1	-	-	1	-	-	1	-	-

**Figure 3.2.3:** Unadjusted patient survival by age, 2001-2010



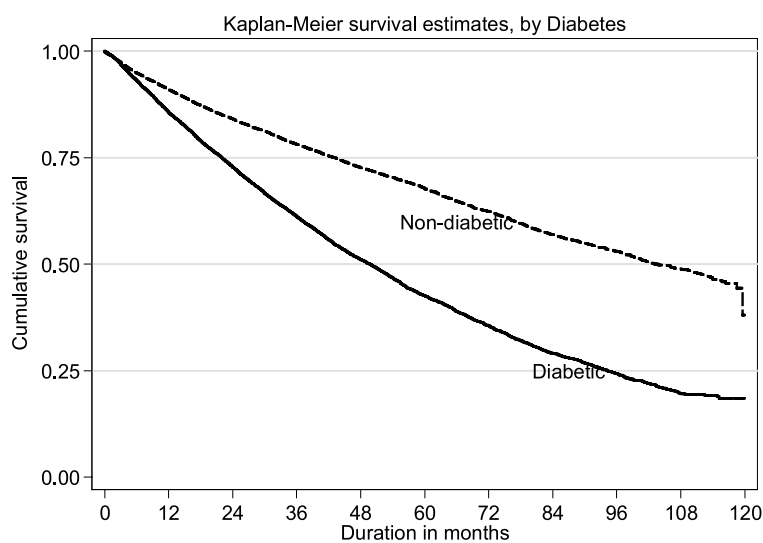
### 3.2.4: Patient survival by Diabetic status

The unadjusted patient survival among diabetic and non-diabetic patients is shown in Table 3.2.4 and Figure 3.2.4. The presence of diabetes mellitus has major impact on patient survival. The difference in the unadjusted patient survival diverged as early as 6 months after initiation of dialysis. The 9 years unadjusted patient survival among diabetics and non-diabetics were 49% and 20% respectively, a two and a half fold difference in patient survival.

**Table 3.2.4:** Unadjusted patient survival by Diabetes status, 2001-2010

Diabetes status Interval (month)	Non-diabetic			Diabetic		
	n	% survival	SE	n	% survival	SE
0	16218	100		20522	100	
6	14230	95	0	17823	93	0
12	12282	91	0	14903	86	0
24	9310	84	0	10297	73	0
36	7068	78	0	6940	61	0
48	5214	73	0	4485	51	0
60	3785	68	0	2737	43	0
72	2684	62	1	1638	36	1
84	1710	57	1	901	29	1
96	1013	53	1	449	24	1
108	445	49	1	150	20	1
120	1	-	-	1	-	-

**Figure 3.2.4:** Unadjusted patient survival by Diabetes status, 2001-2010



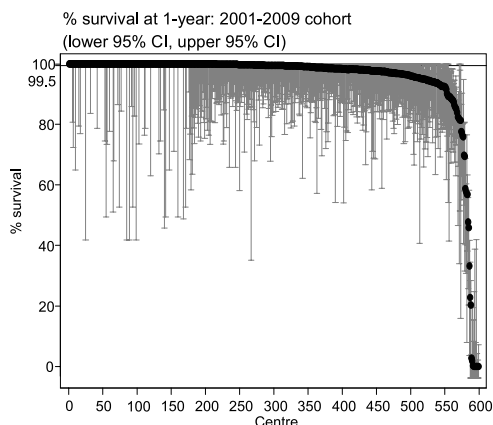


**SECTION 3.3: SURVIVAL OF INCIDENT PATIENTS BY CENTRE**

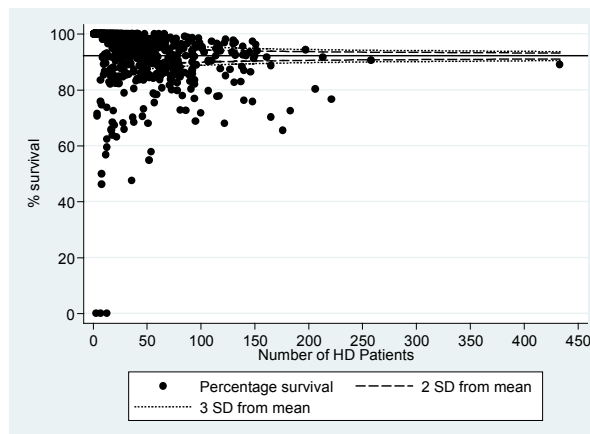
**3.3.1: Survival of incident haemodialysis patients 2001-2010 by centre**

The median patient survival at 1 year (adjusted for age and diabetes) among haemodialysis centres for the 2001-2010 cohort was 92.1% [Figure 3.3.1(a)]. There was a wide centre variation and when the 1 year patient survival of the individual haemodialysis centres were illustrated in the funnel plots [Figure 3.3.1(b)], only 40.1% and 61.0% of the haemodialysis centres lies within the 2SD and 3SD of the median 1 year patient survival respectively.

**Figure 3.3.1 (a):** Variation in patient survival at 1 year among HD centres adjusted for age and diabetes, 2001-2009



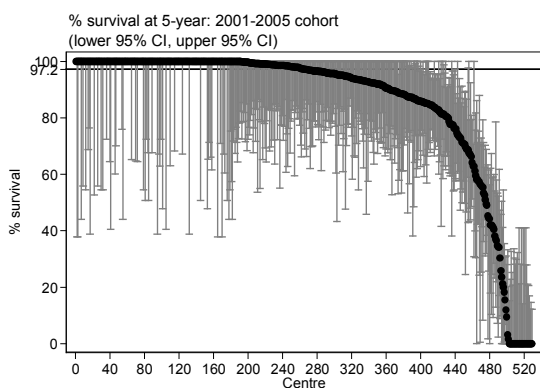
**Figure 3.3.1 (b):** Funnel plot for patient survival at 1 year among HD centres adjusted age and diabetes, 2001-2009 cohort



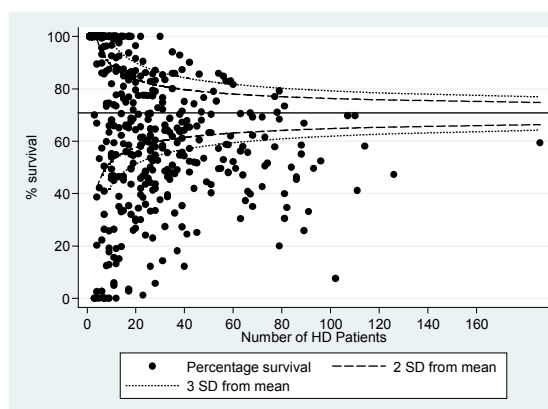
\*Horizontal line represents the median % survival among HD centres

The 5 years median patient survival (adjusted for age and diabetes) among haemodialysis centres for the 2001-2005 cohort was 71.4% [Figure 3.3.1(c)]. As illustrated in the funnel plots [Figure 3.3.1(d)], there was marked centre variation with only 41.5% and 61.9% of haemodialysis centres lie within 2SD and 3SD respectively.

**Figure 3.3.1 (c):** Variation in patient survival at 5-years among HD centres adjusted for age and diabetes, 2001-2005



**Figure 3.3.1 (d):** Funnel plot for patient survival at 5 years among PD centres adjusted for age and diabetes, 2001-2005 cohort

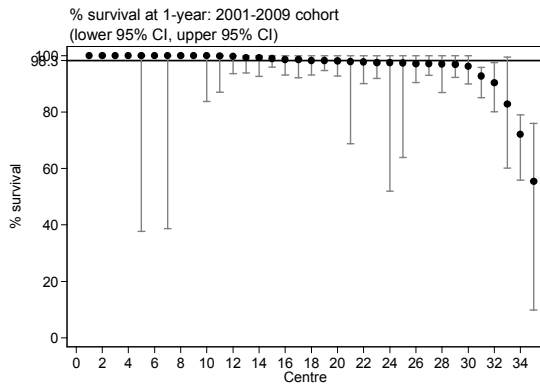


\*Horizontal line represents the median % survival among HD centres

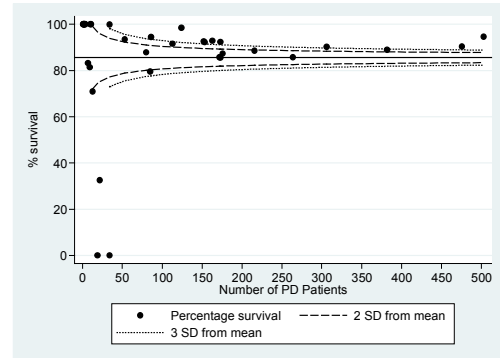
**3.3.2: Survival of incident PD patients by centre**

The median patient survival at 1 year (adjusted for age and diabetes) among peritoneal dialysis for the 2001-2009 cohort was 84.3% [Figure 3.3.2(a)]. There was centre variation and when the 1-year patient survival of the individual peritoneal dialysis centres were illustrated in the funnel plots [Figure 3.3.1(b)], only 50% and 66.7% peritoneal dialysis centres lie within the 2SD and 3SD of the median survival respectively.

**Figure 3.3.2 (a):** Variation in patient survival at 1 year among PD centres adjusted for age and diabetes, 2001-2009



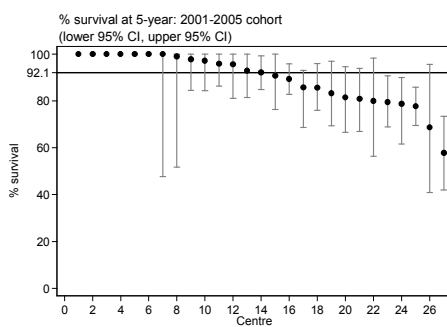
**Figure 3.3.2 (b):** Funnel plot of 1-year patient survival from the 90<sup>th</sup> day of dialysis adjusted for age and diabetes among PD centres, 2001-2009 cohort



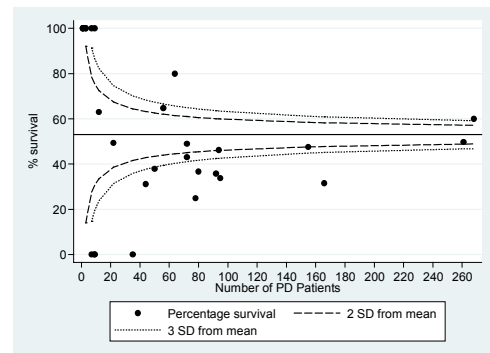
\*Horizontal line represents the median % survival among PD centres

The 5 years median patient survival (adjusted for age and diabetes) among peritoneal centres for the 2001-2005 cohort was 53.0% [Figure 3.3.2(c)]. The 5-year patient survival of the individual peritoneal centres is shown in the funnel plot [Figure 3.3.2(d)]. There was a wide variation in the 5-year survival among PD centres as only 8 out of 28 (28.6%) peritoneal dialysis centres lies within the 2SD of the median survival.

**Figure 3.3.2 (c):** Variation in patient survival at 5-years among PD centres adjusted for age and diabetes, 2001-2005



**Figure 3.3.2 (d):** Funnel plot for 5-year patient survival from 90 days of dialysis adjusted for age and diabetes among PD centres, 2001-2005 cohort



\*Horizontal line represents the median % survival among HD centres

## SECTION 3.4: ADJUSTED MORTALITY OF DIALYSIS PATIENT

### 3.4.1: Adjusted hazard ratio for mortality of dialysis patients

Table 3.4.1 shows the adjusted hazard ratio for mortality of dialysis patients (2001-2010). The 2001-2010 cohort was adjusted for age, gender, primary diagnosis, year commencing dialysis, dialysis modality, body mass index (BMI), serum albumin, serum cholesterol, diastolic blood pressure, haemoglobin, serum calcium, calcium phosphate product, serum phosphate, viral hepatitis status and presence of cardiovascular disease.

Patient variables that had significant impact on mortality were age, gender, primary renal disease, dialysis modality, BMI, diastolic blood pressure and the presence cardiovascular disease. The biochemical risk factors for mortality were serum albumin, serum cholesterol, haemoglobin, calcium, calcium phosphate product and phosphate.

There were positive correlation between mortality and age of patient, diastolic blood pressure [Figure 3.4.1(a)], serum calcium, and serum phosphate [Figure 3.4.1(b)] while negative correlation with BMI, serum albumin, serum cholesterol and haemoglobin concentration [Figure 3.4.1(c)] with mortality. Female patients have 18% lower mortality compared to their male counterpart while patients with diabetic nephropathy as the primary aetiology of renal failure has the highest mortality when compared to other causes of end stage renal failure.

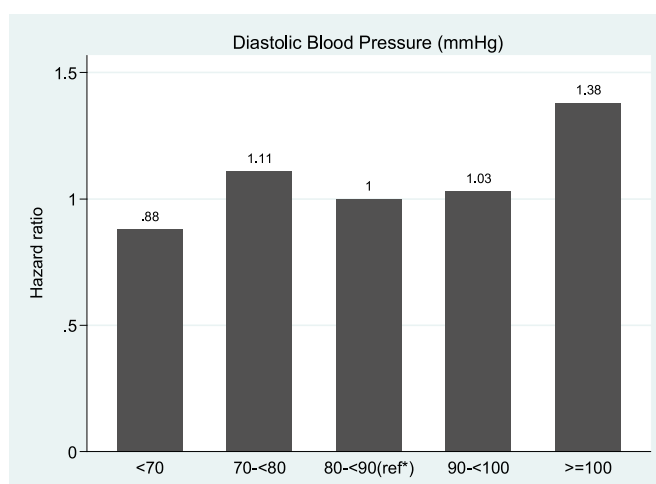
**Table 3.4.1:** Adjusted hazard ratio for mortality of dialysis patients uncensored for change of modality (2001-2010)

Factors	n	Hazard Ratio	95% CI	P-value
Age (years):				
• Age 1-14 (ref <sup>n</sup> )	375	1.00		
• Age 15-24	1197	1.30	(0.96;1.76)	0.093
• Age 25-34	2241	1.50	(1.12; 2.01)	0.006
• Age 35-44	3969	2.05	(1.55;2.72)	<0.001
• Age 45-54	8512	2.88	(2.18;3.81)	<0.001
• Age 55-64	9985	3.68	(2.78; 4.86)	<0.001
• Age >=65	8319	5.16	(3.9;6.83)	<0.001
Gender:				
• Male (ref <sup>n</sup> )	19277	1.00		
• Female	15322	0.82	(0.79; 0.85)	<0.001
Primary diagnosis:				
• Unknown primary	9248	1.30	(1.16;1.47)	<0.001
• Diabetes mellitus	19050	1.87	(1.66;2.1)	<0.001
• GN/SLE (ref <sup>n</sup> )	1740	1.00		
• Polycystic kidney	366	1.15	(0.9;1.45)	0.263
• Obstructive nephropathy	866	1.26	(1.07;1.49)	0.006
• Others	3329	1.17	(1.03;1.34)	0.018
Year start dialysis:				
• 2001-2002 (ref <sup>n</sup> )	4439	1.00		
• 2003-2004	5501	1.04	(0.99;1.1)	0.142
• 2005-2006	3134	1.08	(1.01;1.15)	0.028
• 2007-2008	8595	1.05	(0.99;1.11)	0.126
• 2009-2010	9261	0.93	(0.86;1.01)	0.086
Modality:				
• HD (ref <sup>n</sup> )	30500	1.00		
• PD	4099	1.10	(1.03;1.18)	0.006
BMI:				
• BMI<18.5	2602	1.26	(1.16; 1.37)	<0.001
• BMI 18.5-25	21890	1.15	(1.1;1.21)	<0.001
• >=25 (ref <sup>n</sup> )	10107	1.00		

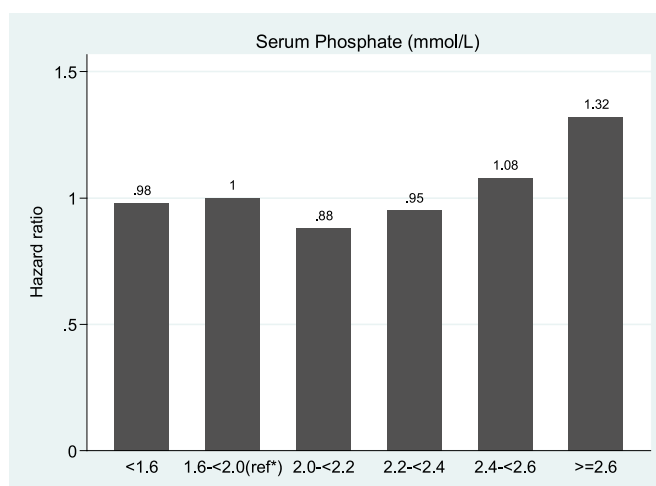
**Table 3.4.1:** Adjusted hazard ratio for mortality of dialysis patients uncensored for change of modality (2001-2010) (cont'd.)

Factors	n	Hazard Ratio	95% CI	P-value
<b>Serum albumin (g/L):</b>				
• <30	2254	3.86	(3.54;4.21)	<0.001
• 30-<35	4838	2.24	(2.09;2.39)	<0.001
• 35-<40	16464	1.79	(1.7;1.88)	<0.001
• ≥40 (ref*)	11043	1.00		
<b>Serum cholesterol (mmol/L):</b>				
• <3.2	1545	1.11	(1.01;1.23)	0.029
• 3.2-<5.2	25175	1.17	(1.11;1.23)	<0.001
• ≥5.2 (ref*)	7879	1.00		
<b>Diastolic BP (mmHg):</b>				
• <70	5201	0.88	(0.83;0.94)	<0.001
• 70-<80	13832	1.11	(1.06;1.16)	<0.001
• 80-<90 (ref*)	11524	1.00		
• 90-<100	3224	1.03	(0.95;1.12)	0.447
• ≥100	818	1.38	(1.19;1.59)	<0.001
<b>Hemoglobin:</b>				
• <8	2655	3.60	(3.3;3.92)	<0.001
• 8-<9	4544	2.42	(2.24;2.62)	<0.001
• 9-<10	10785	2.30	(2.15;2.47)	<0.001
• 10-<11	7628	1.53	(1.42;1.64)	<0.001
• 11-<12 (ref*)	4898	1.00		
• ≥12	2089	1.02	(0.92;1.14)	0.667
<b>Serum calcium (mmol/L):</b>				
• <2.2	14283	1.04	(1;1.09)	0.075
• 2.2-<2.6 (ref*)	19770	1.00		
• ≥2.6	546	1.72	(1.5;1.96)	<0.001
<b>Calcium Phosphate product (mmol<sup>2</sup>/L<sup>2</sup>):</b>				
• <3.5	12421	0.85	(0.79;0.91)	<0.001
• 3.5-<4.5 (ref*)	15076	1.00		
• 4.5-<5.5	5030	0.73	(0.67;0.8)	0.000
• ≥5.5	2072	0.77	(0.66;0.91)	0.002
<b>Serum Phosphate (mmol/L):</b>				
• <1.6	12937	0.98	(0.91;1.05)	0.515
• 1.6-<2.0 (ref*)	14309	1.00		
• 2.0-<2.2	3215	0.88	(0.8;0.96)	0.004
• 2.2-<2.4	1897	0.95	(0.84;1.07)	0.395
• 2.4-<2.6	1059	1.08	(0.92;1.27)	0.322
• ≥2.6	1182	1.32	(1.1;1.59)	0.003
<b>HBsAg:</b>				
• Negative (ref*)	33386	1.00		
• Positive	1213	1.02	(0.93;1.12)	0.688
<b>Anti-HCV:</b>				
• Negative (ref*)	33755	1.00		
• Positive	844	1.02	(0.91;1.13)	0.782
<b>Cardiovascular disease (CVD)</b>				
• No CVD (ref*)	28865	1.00		
• CVD	5734	1.33	(1.27;1.39)	<0.001

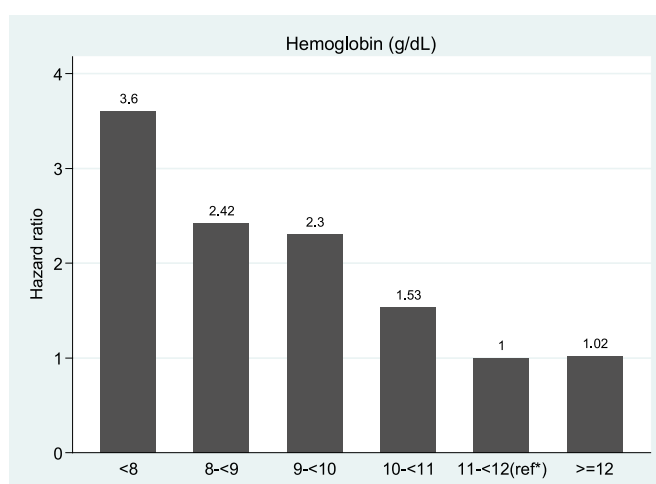
**Figure 3.4.1 (a):** Adjusted hazard ratio for mortality of dialysis patients uncensored for change of modality by diastolic blood pressure (2001-2010 cohort)



**Figure 3.4.1 (b):** Adjusted hazard ratio for mortality of dialysis patients uncensored for change of modality by serum phosphate (2001-2010 cohort)



**Figure 3.4.1 (c):** Adjusted hazard ratio for mortality of dialysis patients uncensored for change of modality by hemoglobin (2001-2010 cohort)



### 3.4.2: Adjusted hazard ratio for mortality of haemodialysis patients

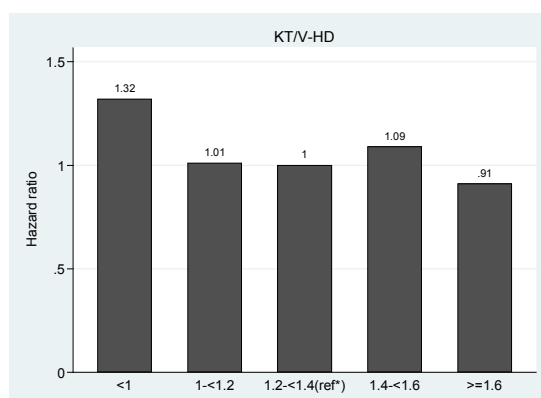
The adjusted hazard ratio for mortality for hemodialysis patients [Table 3.4.2] in this cohort demonstrated identical pattern with the whole cohort of 2001-2010 dialysis patients since more than 90% of this dialysis population consisted of haemodialysis patients. The dose of dialysis treatment (Kt/V) [Figure 3.4.2] was negatively correlation with mortality with hemodialysis patients with Kt/V of  $\geq 1.6$  having the lowest adjusted hazard ratio for mortality.

**Table 3.4.2:** Adjusted hazard ratio for mortality of HD patients uncensored for change of modality (2001-2010 cohort)

Factors	n	Hazard Ratio	95% CI	P-value
<b>Age (years):</b>				
• Age 1-14 (ref <sup>n</sup> )	72	1.00		
• Age 15-24	838	1.05	(0.53;2.07)	0.899
• Age 25-34	1,895	1.15	(0.59;2.23)	0.689
• Age 35-44	3,494	1.54	(0.79;2.98)	0.203
• Age 45-54	7,642	2.14	(1.11;4.13)	0.024
• Age 55-64	8,988	2.75	(1.42;5.31)	0.003
• Age $\geq 65$	7,570	3.80	(1.97;7.35)	<0.001
<b>Gender:</b>				
• Male (ref <sup>n</sup> )	17,215	1.00		
• Female	13,285	0.84	(0.8;0.88)	<0.001
<b>Primary diagnosis:</b>				
• Unknown primary (ref <sup>n</sup> )	8,334	1.00		
• Diabetes mellitus	17,062	1.40	(1.33;1.47)	<0.001
• GN/SLE	1,224	0.73	(0.64;0.84)	<0.001
• Polycystic kidney	327	0.90	(0.72;1.13)	0.362
• Obstructive nephropathy	698	0.97	(0.84;1.11)	0.663
• Others	2,855	0.92	(0.85;1)	0.064
<b>Year start dialysis:</b>				
• 2000-2001 (ref <sup>n</sup> )	14	1.00		
• 2002-2003	4,840	1.05	(0.99;1.11)	0.085
• 2004-2005	2,820	1.11	(1.03;1.19)	0.004
• 2006-2007	7,512	1.05	(0.99;1.12)	0.129
• 2008-2009	8,213	0.96	(0.88;1.04)	0.289
<b>BMI:</b>				
• BMI<18.5	2,054	1.38	(1.25;1.52)	<0.001
• BMI 18.5-25	19,801	1.20	(1.14;1.27)	<0.001
• $\geq 25$ (ref <sup>n</sup> )	8,645	1.00		
<b>Serum albumin (g/L):</b>				
• <30	1,049	4.43	(4.01;4.9)	<0.001
• 30-<35	3,266	2.23	(2.07;2.4)	<0.001
• 35-<40	15,444	1.81	(1.72;1.91)	<0.001
• $\geq 40$ (ref <sup>n</sup> )	10,741	1.00		
<b>Serum cholesterol (mmol/L):</b>				
• <3.2	1,476	1.13	(1.02;1.26)	0.016
• 3.2-<5.2	23,168	1.22	(1.15;1.29)	<0.001
• $\geq 5.2$ (ref <sup>n</sup> )	5,856	1.00		
<b>Kt/V</b>				
• <1	786	1.32	(1.15;1.52)	<0.001
• 1-<1.2	2,718	1.01	(0.93;1.09)	0.865
• 1.2-<1.4 (ref <sup>n</sup> )	5,836	1.00		
• 1.4-<1.6	8,643	1.09	(1.02;1.15)	0.008
• $\geq 1.6$	12,517	0.91	(0.85;0.97)	0.004

**Table 3.4.2:** Adjusted hazard ratio for mortality of HD patients uncensored for change of modality (2001-2010 cohort) (cont'd.)

Factors	n	Hazard Ratio	95% CI	P-value
<b>Diastolic BP (mmHg):</b>				
• <70	4,680	0.85	(0.79;0.91)	<0.001
• 70-<80	12,348	1.11	(1.06;1.17)	<0.001
• 80-<90 (ref*)		1.00		
• 90-<100	2,750	1.03	(0.94;1.12)	0.544
• ≥100	753	1.41	(1.21;1.65)	<0.001
<b>Hemoglobin:</b>				
• <8	2,460	4.01	(3.64;4.4)	<0.001
• 8-<9	4,079	2.69	(2.47;2.94)	<0.001
• 9-<10	9,845	2.60	(2.4;2.81)	<0.001
• 10-<11	8,334	1.63	(1.5;1.76)	<0.001
• 11-<12 (ref*)	4,103	1.00		
• ≥12	1,679	1.02	(0.89;1.16)	0.811
<b>Serum calcium (mmol/L):</b>				
• <2.2	12,589	1.05	(1;1.1)	0.048
• 2.2-<2.6 (ref*)	17,461	1.00		
• ≥2.6	450	1.79	(1.55;2.08)	<0.001
<b>Calcium Phosphate product (mmol<sup>2</sup>/L<sup>2</sup>):</b>				
• <3.5	10,050	0.80	(0.75;0.87)	<0.001
• 3.5-<4.5 (ref*)	13,905	1.00		
• 4.5-<5.5	4,614	0.73	(0.66;0.8)	<0.001
• ≥5.5	1,931	0.76	(0.64;0.9)	0.001
<b>Serum Phosphate (mmol/L):</b>				
• <1.6	10,480	0.97	(0.9;1.05)	0.476
• 1.6-<2.0 (ref*)	13,203	1.00		
• 2.0-<2.2	2,983	0.83	(0.75;0.91)	<0.001
• 2.2-<2.4	1,742	0.92	(0.81;1.05)	0.216
• 2.4-<2.6	981	1.03	(0.87;1.22)	0.736
• ≥2.6	1,111	1.27	(1.05;1.55)	0.014
<b>HBsAg:</b>				
• Negative (ref*)	29,431	1.00		
• Positive	1,069	1.02	(0.92;1.13)	0.712
<b>Anti-HCV:</b>				
• Negative (ref*)	29,723	1.00		
• Positive	777	1.01	(0.9;1.13)	0.889
<b>Cardiovascular disease (CVD)</b>				
• No CVD (ref*)	25,653	1.00		
• CVD	4,847	1.30	(1.24;1.36)	<0.001

**Figure 3.4.2:** Adjusted hazard ratio for mortality of HD patients uncensored for change of modality by Kt/V (2001-2010 cohort)

### 3.4.3: Adjusted hazard ratio for mortality of peritoneal dialysis patients

The adjusted hazard ratio for peritoneal dialysis patients [Table 3.4.3] showed similarity to the whole cohort of 2001-2010 dialysis patients. However correlations of gender and serum cholesterol with mortality were not demonstrated in peritoneal dialysis patients. This difference could be partly contributed by the smaller number of peritoneal dialysis patients in this cohort. The unadjusted hazard ratio for mortality in peritoneal dialysis patients for Kt/V less than 1.7 was 2.44 when compared to Kt/V of 1.7-2.0 [Figure 3.4.3 (a)]. However the negative correlation of Kt/V with mortality was reversed when adjusted for the various confounding variables but it did not reached statistical significant [Table 3.4.3 & Figure 3.4.3 (b)].

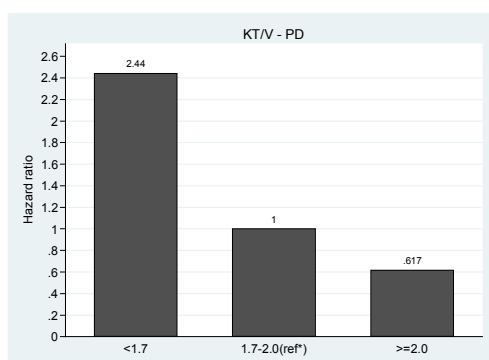
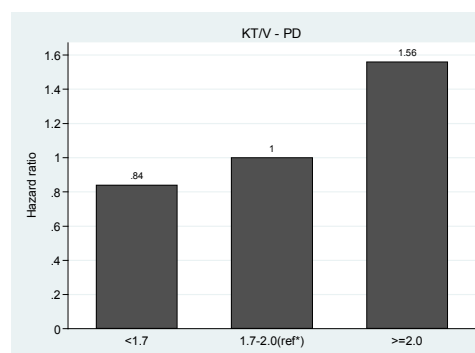
**Table 3.4.3:** Adjusted hazard ratio for mortality of PD patients uncensored for change of modality (2001-2010 cohort)

Factors	n	Hazard Ratio	95% CI	P-value
<b>Age (years):</b>				
• Age 1-14 (ref <sup>n</sup> )	303	1.00		
• Age 15-24	359	2.07	(1.2;3.55)	0.008
• Age 25-34	346	2.60	(1.3;5.18)	0.007
• Age 35-44	475	3.77	(1.92;7.41)	<0.001
• Age 45-54	870	5.94	(3.02;11.68)	<0.001
• Age 55-64	997	6.70	(3.43;13.08)	<0.001
• Age >=65	749	10.72	(5.46;21.07)	<0.001
<b>Gender:</b>				
• Male (ref <sup>n</sup> )	2,062	1.00		
• Female	2,037	0.90	(0.8;1.02)	0.096
<b>Primary diagnosis:</b>				
• Unknown primary (ref <sup>n</sup> )	914	1.00		
• Diabetes mellitus	1,988	1.85	(1.53;2.23)	<0.001
• GN/SLE	516	0.84	(0.65;1.1)	0.206
• Polycystic kidney	39	0.67	(0.35;1.26)	0.212
• Obstructive nephropathy	168	1.06	(0.76;1.49)	0.718
• Others	474	0.88	(0.7;1.09)	0.242
<b>Year start dialysis:</b>				
• 2000-2001 (ref <sup>n</sup> )	595	1.00		
• 2002-2003	661	0.97	(0.84;1.12)	0.676
• 2004-2005	314	0.86	(0.7;1.04)	0.123
• 2006-2007	1,083	0.90	(0.77;1.06)	0.201
• 2008-2009	1,048	0.67	(0.53;0.84)	0.001
<b>BMI:</b>				
• BMI<18.5	548	1.44	(1.15;1.8)	0.001
• BMI 18.5-25	2,089	1.12	(1;1.26)	0.052
• >=25 (ref <sup>n</sup> )	1,462	1.00		
<b>Serum albumin (g/L):</b>				
• <30	1,205	1.64	(1.24;2.15)	<0.001
• 30-<35	1,572	1.12	(0.86;1.46)	0.416
• 35-<40	1,020	0.83	(0.63;1.09)	0.183
• >=40 (ref <sup>n</sup> )	302	1.00		
<b>Serum cholesterol (mmol/L):</b>				
• <3.2	69	1.26	(0.86;1.85)	0.244
• 3.2-<5.2	2,007	0.96	(0.86;1.07)	0.469
• >=5.2 (ref <sup>n</sup> )	2,023	1.00		
<b>Kt/V</b>				
• <=1.7	2,848	0.84	(0.67;1.07)	0.161
• 1.7-<=2.0 (ref <sup>n</sup> )	853	1.00		
• >2.0	398	1.56	(0.9;2.7)	0.116



**Table 3.4.3:** Adjusted hazard ratio for mortality of PD patients uncensored for change of modality (2001-2010 cohort) (cont'd.)

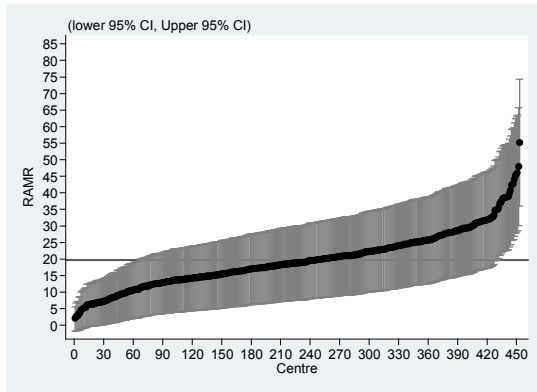
Factors	n	Hazard Ratio	95% CI	P-value
<b>Diastolic BP (mmHg):</b>				
• <70	521	1.21	(1.02;1.44)	0.033
• 70-<80	1,484	1.02	(0.89;1.15)	0.802
• 80-<90 (ref <sup>*</sup> )	1,555	1.00		
• 90-<100	474	1.11	(0.91;1.34)	0.310
• ≥100	65	0.90	(0.54;1.52)	0.697
<b>Hemoglobin:</b>				
• <8	195	1.92	(1.47;2.51)	<0.001
• 8-<9	465	1.58	(1.3;1.94)	<0.001
• 9-<10	940	1.34	(1.14;1.58)	0.001
• 10-<11	1,294	1.16	(0.99;1.35)	0.061
• 11-<12 (ref <sup>*</sup> )	795	1.00		
• ≥12	410	0.96	(0.78;1.19)	0.718
<b>Serum calcium (mmol/L):</b>				
• <2.2	1,694	0.97	(0.86;1.09)	0.594
• 2.2-<2.6 (ref <sup>*</sup> )	2,309	1.00		
• ≥2.6	96	1.55	(1.15;2.1)	0.004
<b>Calcium Phosphate product (mmol<sup>2</sup>/L<sup>2</sup>):</b>				
• <3.5	2,371	1.16	(0.96;1.42)	0.131
• 3.5-<4.5 (ref <sup>*</sup> )	1,171	1.00		
• 4.5-<5.5	416	0.85	(0.65;1.11)	0.232
• ≥5.5	141	0.85	(0.51;1.42)	0.539
<b>Serum Phosphate (mmol/L):</b>				
• <1.6	2,457	1.19	(0.97;1.46)	0.097
• 1.6-<2.0 (ref <sup>*</sup> )	1,106	1.00		
• 2.0-<2.2	232	1.71	(1.28;2.29)	0.000
• 2.2-<2.4	155	1.26	(0.85;1.89)	0.254
• 2.4-<2.6	78	1.80	(1.11;2.93)	0.018
• ≥2.6	71	1.80	(0.95;3.39)	0.070
<b>HBsAg:</b>				
• Negative (ref <sup>*</sup> )	3955	1.00		
• Positive	144	0.95	(0.73;1.24)	0.725
<b>Anti-HCV:</b>				
• Negative (ref <sup>*</sup> )	4032	1.00		
• Positive	67	1.18	(0.81;1.72)	0.376
<b>Cardiovascular disease (CVD)</b>				
• No CVD (ref <sup>*</sup> )	3212	1.00		
• CVD	887	1.38	(1.22;1.55)	<0.001

**Figure 3.4.3(a):** Unadjusted hazard ratio for mortality of PD patients uncensored for change of modality Kt/V (2001-2010)**Figure 3.4.3(b):** Adjusted hazard ratio for mortality of PD patients uncensored for change of modality by Kt/V (2001-2010 cohort)

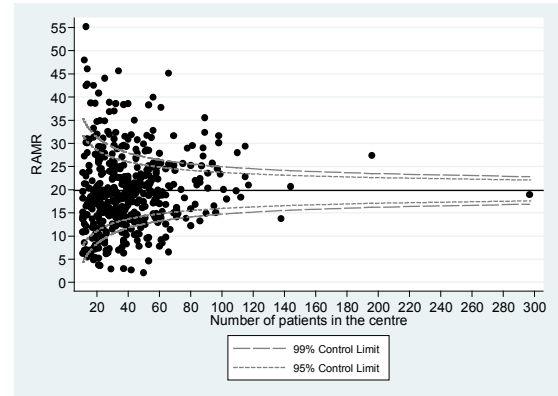
**3.4.4: Risk Adjusted Mortality Rate for haemodialysis patients by haemodialysis centres**

The median risk adjusted mortality rate (RAMR) for haemodialysis patients by HD centres was 18.89. There was a marked centre variations in RAMR ranging from 2.05 to 55.19. [Figure 3.4.4(a)]. Despite taking into account the size of the haemodialysis centres, the variation of the RAMR rate among the various haemodialysis centres in this country persisted as demonstrated in the funnel plot [Figure 3.4.4(b)].

**Figure 3.4.4(a):** Variations in RAMR by HD centres, 2009



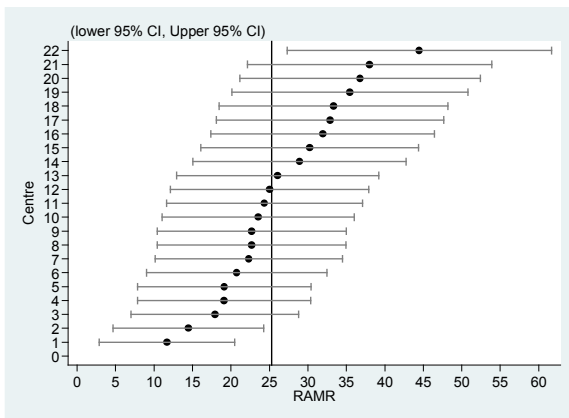
**Figure 3.4.4(b):** Funnel plot of RAMR by HD centre, 2009



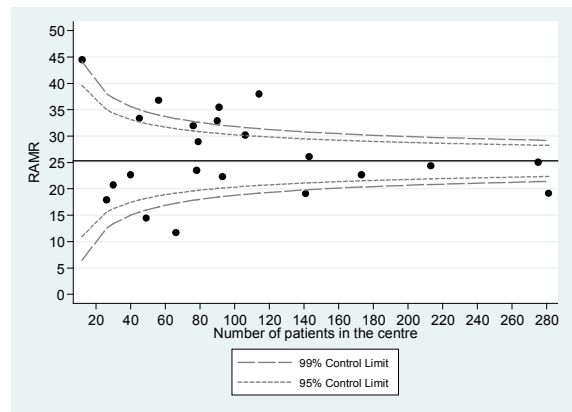
**3.4.5: Risk Adjusted Mortality Rate by PD centres**

The median risk adjusted mortality rate (RAMR) for peritoneal dialysis patients by PD centres was 24.70. There was a marked centre variations in RAMR ranging from ranging from 11.69 to 44.48 [Figure 3.4.5(a)]. Taking into account of the size of the PD centre, 36% of the PD centres lie outside the 3SD as demonstrated in the funnel plot [Figure 3.4.5(b)].

**Figure 3.4.5(a):** Variations in RAMR by PD centres, 2009



**Figure 3.4.5(b):** Funnel plot for RAMR by PD centres, 2009





## CHAPTER 4

# **QUALITY OF LIFE AND REHABILITATION OUTCOMES OF PATIENTS ON DIALYSIS**

Liu Wen Jiun  
Chew Thian Fook  
Christopher Lim Thiam Seong  
Zaki Morad B Mohd Zaher

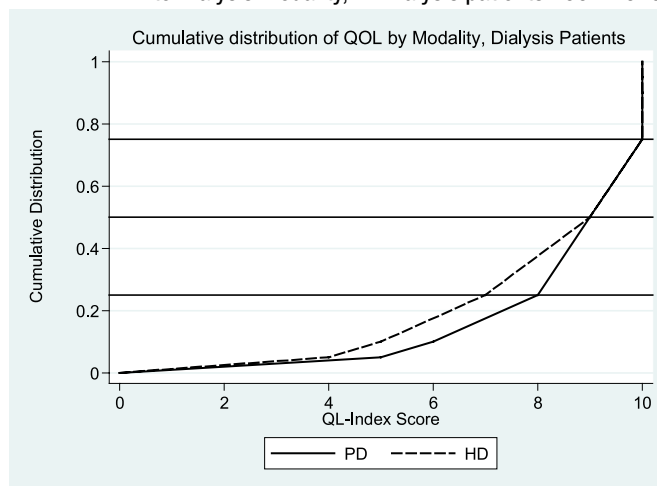
**SECTION A : QoL INDEX SCORE**

27563 patients who entered dialysis between 2001-2010 were analysed. 23403 HD patients and 4160 CAPD patients both reported median QoL index score of 9 (Table 4.1, Figure 4.1) Diabetics have a lower median QoL index score than non-diabetics (8 versus 10) (Table 4.2, Figure 4. 2) whilst there was no difference seen between gender (Table 4.3, Figure 4.3). There is a trend of lower median QoL index score being associated with older dialysis patients (Table 4.4, Figure 4.4). There are no obvious trends in QoL index seen either in the HD or CAPD cohort over the last 10 years. (Table & Figure 4.5, Table & Figure 4.6)

**Table 4.1:** Cumulative distribution of QoL-Index score in relation to dialysis modality, All dialysis patients 2001-2010

Dialysis modality	PD	HD
Number of patients	4160	23403
Centile		
0	0	0
0.05	5	4
0.1	6	5
0.25 (LQ)	8	7
0.5 (median)	9	9
0.75 (UQ)	10	10
0.9	10	10
0.95	10	10
1	10	10

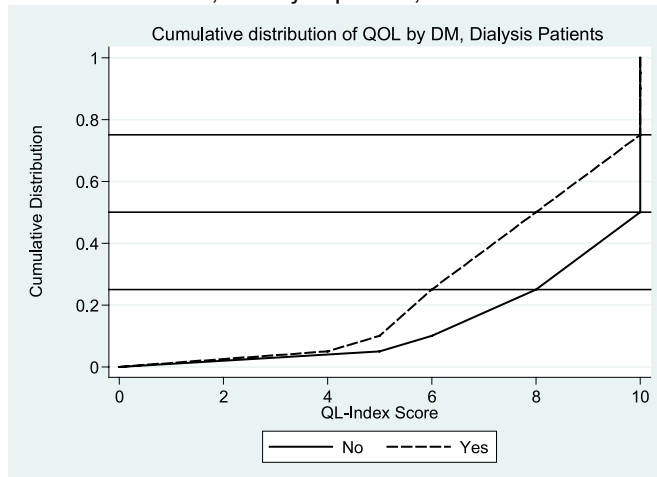
**Figure 4.1:** Cumulative distribution of QoL-Index score in relation to Dialysis Modality, All Dialysis patients 2001-2010



**Table 4.2:** Cumulative distribution of QoL-Index score in relation to DM, All dialysis patients 2001-2010

Diabetes mellitus	No	Yes
Number of patients	13351	14212
Centile		
0	0	0
0.05	5	4
0.1	6	5
0.25 (LQ)	8	6
0.5 (median)	10	8
0.75 (UQ)	10	10
0.9	10	10
0.95	10	10
1	10	10

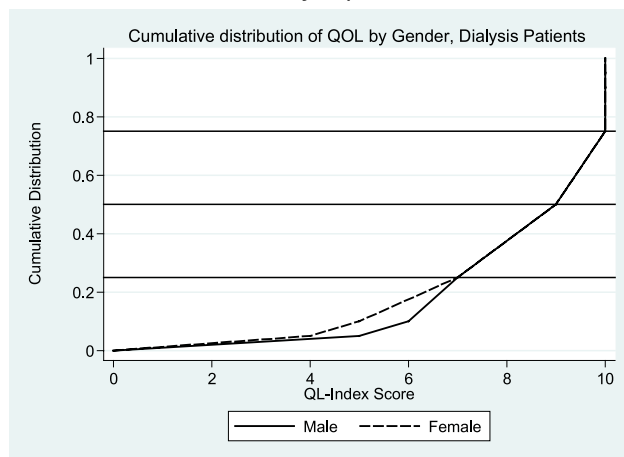
**Figure 4.2:** Cumulative distribution of QoL-Index score in relation to DM, All Dialysis patients, 2001-2010



**Table 4.3:** Cumulative distribution of QoL-index score in relation to Gender, All Dialysis patients 2001-2010

Gender	Male	Female
Number of patients	15252	12311
Centile		
0	0	0
0.05	5	4
0.1	6	5
0.25 (LQ)	7	7
0.5 (median)	9	9
0.75 (UQ)	10	10
0.9	10	10
0.95	10	10
1	10	10

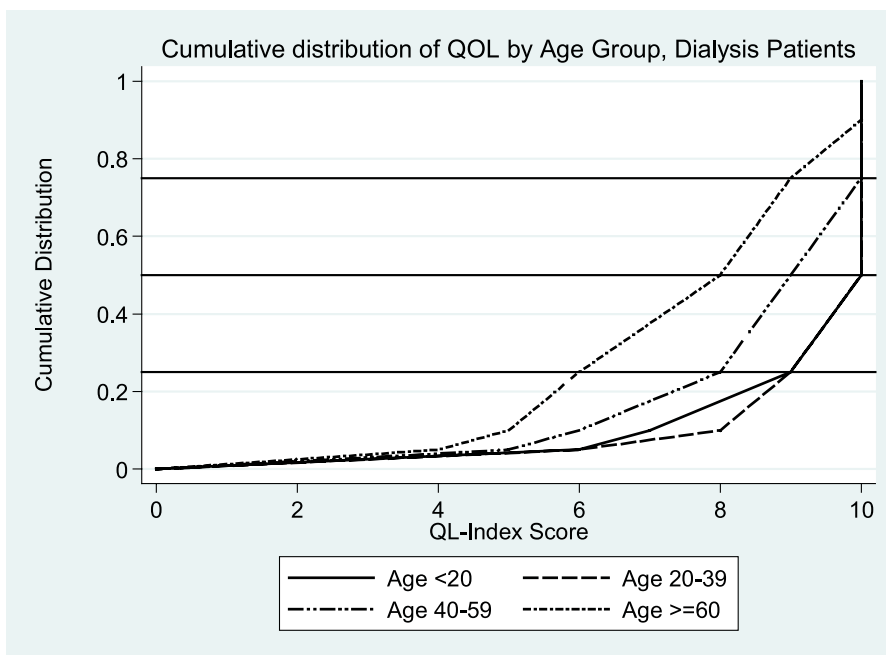
**Figure 4.3:** Cumulative distribution of QoL-Index score in relation to Gender, All Dialysis patients, 2001-2010



**Table 4.4:** Cumulative distribution of QoL-index score in relation to Age, All Dialysis patients 2001-2010

Age group	<20	20-39	40-59	>=60
Number of patients	888	4146	13059	9470
Centile				
0	0	0	0	0
0.05	6	6	5	4
0.1	7	7	6	5
0.25 (LQ)	9	9	7	6
0.5 (median)	10	10	9	8
0.75 (UQ)	10	10	10	9
0.9	10	10	10	10
0.95	10	10	10	10
1	10	10	10	10

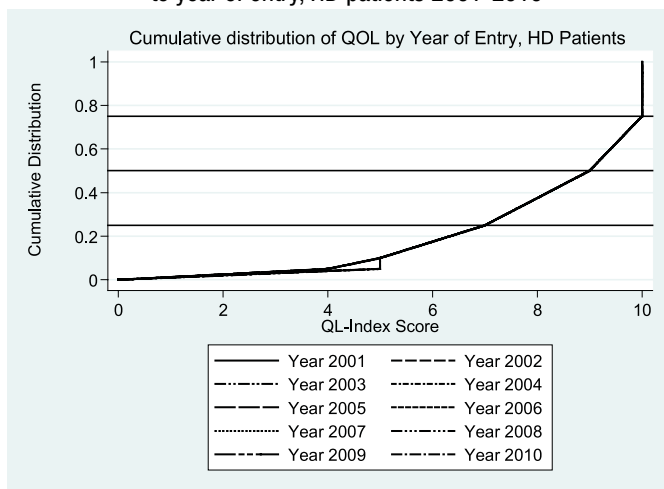
**Figure 4.4:** Cumulative distribution of QoL-Index score in relation to Age, All Dialysis patients, 2001-2010



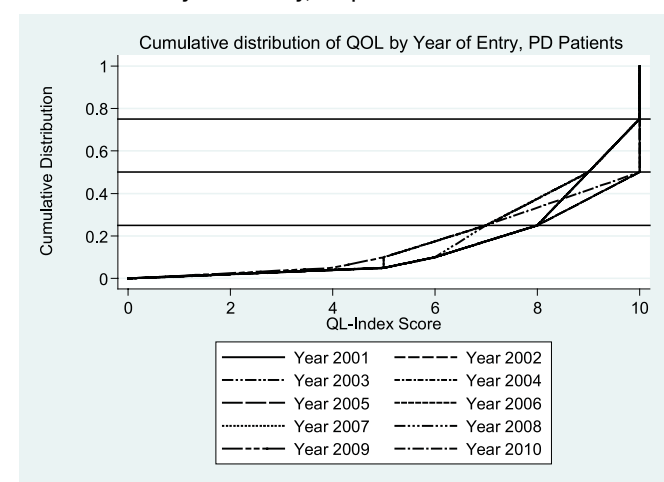
**Table 4.5:** Cumulative distribution of QoL-Index score in relation to year of entry, HD patients 2001-2010

Year of Entry	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Number of patients	1449	1668	1739	2098	2211	2606	2761	3153	3243	2475
Centile										
0	0	0	0	0	0	0	0	0	0	0
0.05	5	4	5	4	4	4	4	5	4	4
0.1	5	5	5	5	5	5	5	5	5	5
0.25 (LQ)	7	7	7	7	7	7	7	7	7	7
0.5 (median)	9	9	9	9	9	9	9	9	9	9
0.75 (UQ)	10	10	10	10	10	10	10	10	10	10
0.9	10	10	10	10	10	10	10	10	10	10
0.95	10	10	10	10	10	10	10	10	10	10
1	10	10	10	10	10	10	10	10	10	10

**Figure 4.5:** Cumulative distribution of QoL-Index score in relation to year of entry, HD patients 2001-2010



**Figure 4.6:** Cumulative distribution of QoL-Index score in relation to year of entry, PD patients 2001-2010



**Table 4.6:** Cumulative distribution of QoL-Index score in relation to year of entry, PD patients 2001-2010

Year of Entry	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Number of patients	269	320	369	307	319	425	526	576	577	472
Centile										
0	0	0	0	0	0	0	0	0	0	0
0.05	5	5	5	5	5	5	5	5	4	5
0.1	6	6	6	6	6	6	5	6	5	5
0.25 (LQ)	8	8	8	8	8	8	7	7	7	7
0.5 (median)	10	10	9	9	9	9	9	9	9	10
0.75 (UQ)	10	10	10	10	10	10	10	10	10	10
0.9	10	10	10	10	10	10	10	10	10	10
0.95	10	10	10	10	10	10	10	10	10	10
1	10	10	10	10	10	10	10	10	10	10

## SECTION B : WORK RELATED REHABILITATION

Analysis was done on HD patients (n=8864) and CAPD patients (n=1347) who entered dialysis between 2001-2010 (Table 4.7). Only patients who are working for pay and those who are unable to work for pay due to health reasons are included. PD category has a slightly higher proportion of patients on employment compared to HD category. (PD 71% vs HD 69%)

Amongst HD as well as CAPD patients, the proportion on employment increases with longer duration on dialysis. (Table 4.8 and Table 4.9) This may be confounded by the healthier individuals who survived longer in the earlier cohort and therefore spuriously increased the proportion on employment.

**Table 4.7:** Work related rehabilitation in relation to modality, dialysis patients, 2001-2010

Modality	PD		HD	
	n	%	n	%
Number of patients	1347	-	8864	-
Able to return for Full or Part time for pay*	961	71	6093	69
Unable to work for pay	386	29	2771	31

**Table 4.8:** Work related rehabilitation in relation to year of entry, HD patients 2001-2010

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Number of patients	628	714	733	852	856	1005	1016	1188	1083	789	
Able to return for Full or Part time for pay*	n	457	535	540	609	608	715	711	783	689	446
	%	73	75	74	71	71	71	70	66	64	57
Unable to work for pay	n	171	179	193	243	248	290	305	405	394	343
	%	27	25	26	29	29	29	30	34	36	43

**Table 4.9:** Work related rehabilitation in relation to year of entry, PD patients 2001-2010

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Number of patients	85	120	141	103	113	147	168	184	146	140	
Able to return for Full or Part time for pay*	n	69	90	109	73	84	105	115	126	96	94
	%	81	75	77	71	74	71	68	68	66	67
Unable to work for pay	n	16	30	32	30	29	42	53	58	50	46
	%	19	25	23	29	26	29	32	32	34	33

### Summary :

Median QoL index scores are satisfactory in both HD and CAPD patients (score of 9). Diabetes Mellitus and older age group are factors associated with lower median QoL index scores. Higher employment rate amongst HD and CAPD patients who started dialysis earlier may be confounded by these healthier individuals who survived longer.





CHAPTER 5

**PAEDIATRIC RENAL  
REPLACEMENT THERAPY**

Lee Ming Lee

Lim Yam Ngo

Lynster Liaw

Susan Pee

Wan Jazilah Wan Ismail

### SECTION A: RRT PROVISION FOR PAEDIATRIC PATIENTS

This chapter presents data on paediatric patients less than 20 years of age receiving renal replacement therapy (RRT) from 2001 to 2010.

The dialysis acceptance rate for the paediatric population had increased to 10 per million age related population (pmarp) in 2009 and 8 pmarp in 2010 (data for 2010 however is preliminary as at the time of writing this report there might still be some new patients yet to be notified to the registry).

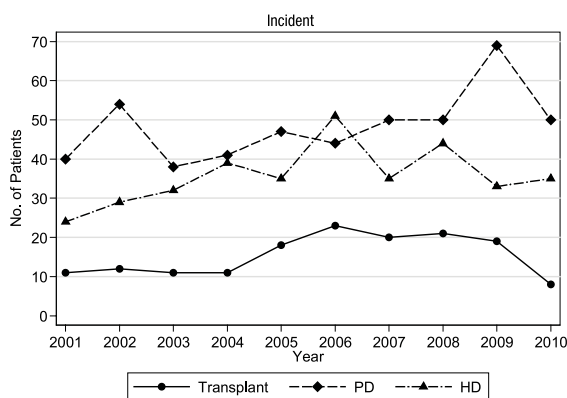
There has been a drop in the number of new transplant done in 2010 after an initial encouraging increase over the last 5 years with about 20 new transplants yearly. The overall incidence rate for all RRT was 10 pmarp in 2009 and 8 pmarp in 2010.

As expected, with increasing number of children on dialysis and improve survival; the number of prevalent patients continue to rise. At the end of 2010, 823 paediatric patients were receiving RRT in Malaysia. Of these, 633 children were on dialysis. The equivalent dialysis prevalence rate more than doubled over the last 10 years from 35 pmarp in 2001 to 78 pmarp in 2010. The prevalent HD population continued to expand at a higher rate than the PD population although the dialysis acceptance rate for new PD patients was higher, consistent with higher technique failure among PD patients.

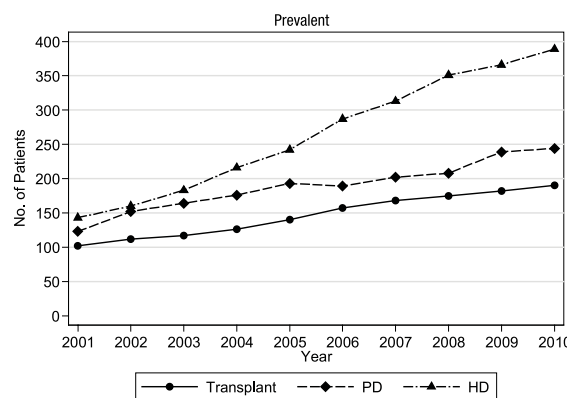
**Table 5.1:** Stock and Flow of Paediatric Renal Replacement Therapy 2001-2010

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
New HD patients	24	29	32	39	35	51	35	44	33	35
New PD patients	40	54	38	41	47	44	50	50	69	50
New Transplants	11	12	11	11	18	23	20	21	19	8
HD deaths	1	11	6	10	9	7	11	11	13	15
PD deaths	8	8	12	6	9	17	8	11	11	16
Transplant deaths	0	1	2	0	1	1	3	4	2	2
On HD at 31 <sup>st</sup> December	143	160	183	216	242	287	313	351	366	389
On PD at 31 <sup>st</sup> December	123	152	164	176	193	189	202	208	239	244
Functioning transplant at 31 <sup>st</sup> December	102	112	117	126	140	157	168	175	182	190

**Figure 5.1 (a):** Incident cases of RRT by modality in children under 20 years old, 2001-2010

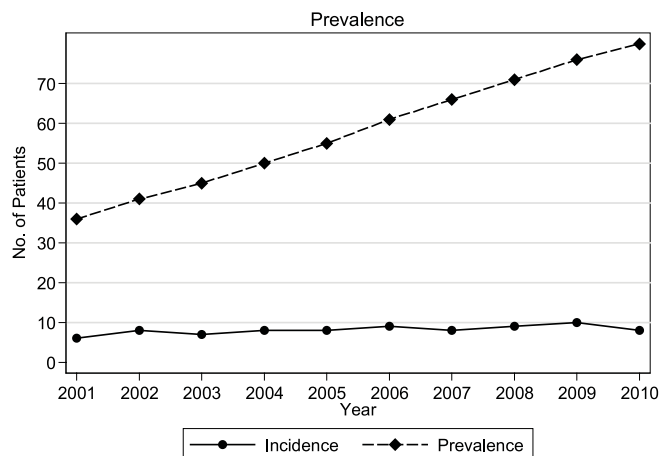


**Figure 5.1 (b):** Prevalent cases of RRT by modality in children under 20 years old, 2001-2010



**Table 5.2:** Paediatric Dialysis and Transplant Rates per million age-group population 2001-2010

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
<b>Incidence Rate</b>										
New HD	2	3	3	4	3	5	3	4	3	3
New PD	4	5	4	4	5	4	5	5	7	5
New Transplant	1	1	1	1	2	2	2	2	2	1
All RRT	6	8	7	8	8	9	8	9	10	8
<b>Prevalence Rate at 31<sup>st</sup> December</b>										
On HD	14	15	18	21	23	28	30	34	35	38
On PD	12	15	16	17	19	18	19	20	23	24
Functioning Graft	10	11	11	12	13	15	16	17	18	18
All RRT	35	40	44	49	54	60	64	70	75	78

**Figure 5.2:** Incidence and prevalence rate per million age related population years old on RRT, 2001-2010

## SECTION B: DISTRIBUTION OF PAEDIATRIC DIALYSIS PATIENTS

The treatment gap between the more economically developed states of West Malaysia and East Malaysia had become less obvious over the years with the set up of new paediatric and adult nephrology centres in these regions particularly in East Malaysia where the number of new dialysis patients had doubled over the last 5 years.

**Table 5.3 (a):** Dialysis Treatment Rate by State, per million state age group populations; 2001-2010

State	2001-2005	2006-2010
Pulau Pinang	11	14
Melaka	13	9
Johor	9	10
Perak	7	8
Selangor & Putrajaya	6	9
Kuala Lumpur	7	13
Negeri Sembilan	10	6
Kedah	8	6
Perlis	10	9
Terengganu	8	11
Pahang	6	10
Kelantan	7	6
Sarawak	6	8
Sabah & WP Labuan	4	7

**Table 5.3 (b):** New Dialysis Patients by State, 2001-2010

State	2001-2005	2006-2010
Pulau Pinang	29	36
Melaka	19	14
Johor	52	59
Perak	35	38
Selangor & Putrajaya	53	82
Kuala Lumpur	20	36
Negeri Sembilan	19	11
Kedah	31	25
Perlis	5	4
Terengganu	19	24
Pahang	19	27
Kelantan	26	25
Sarawak	30	37
Sabah & WP Labuan	21	42

There had been consistently more males compared to females among the population of children on dialysis and transplant. This trend had persisted over the last 10 years; probably a reflection of the higher incidence of ESRD among the males. However this gender disparity appears to be less marked in the recent years perhaps reflecting a gender bias in the early years.

**Table 5.4:** Number of New Dialysis and Transplant Patients by Gender 2001-2010

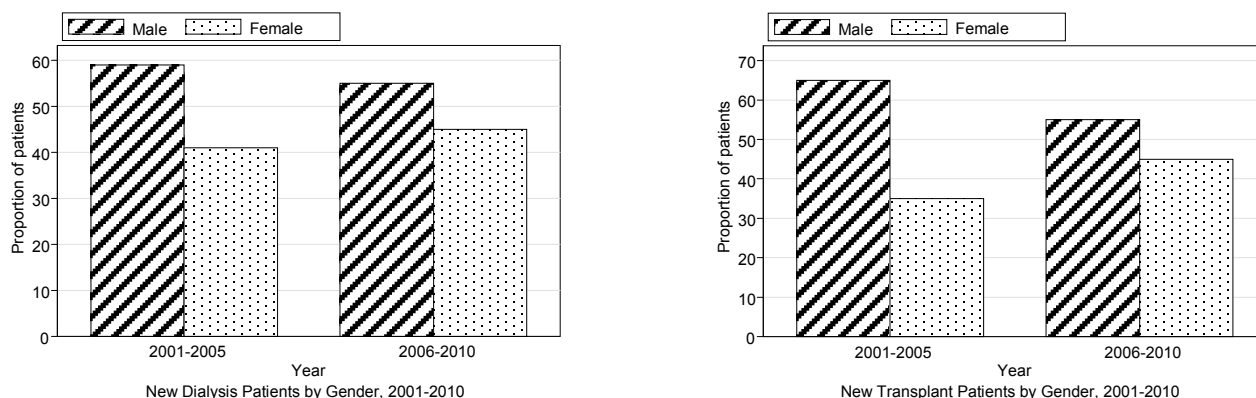
### a) New Dialysis

Year	Male		Female	
	n	%	n	%
2001-2005	224	59	155	41
2006-2010	254	55	207	45

### b) New Transplant

Year	Male		Female	
	n	%	n	%
2001-2005	41	65	22	35
2006-2010	50	55	41	45

**Figure 5.4:** Number of New Dialysis and Transplant Patients by gender 2001-2010

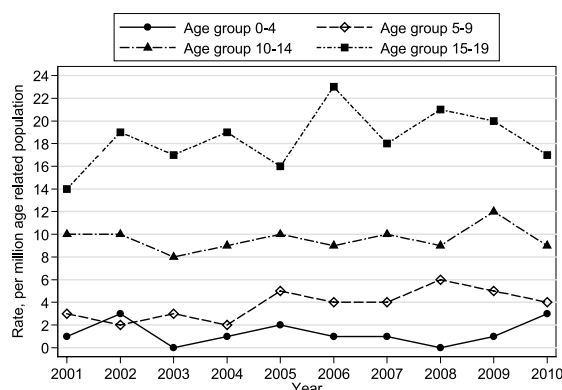


The dialysis treatment rate had leveled off over the last 10 years across the paediatric age spectrum. The treatment rate had remained consistently higher among the older age groups while the number of 0-4 year olds provided chronic dialysis treatment remained very low.

**Table 5.5:** New RRT Rate, Per Million Age Related Population by Age Group 2001-2010

Year	New RRT rate, pmp			
	Age group (years)			
	0-4	5-9	10-14	15-19
2001	1	3	10	14
2002	3	2	10	19
2003	0	3	8	17
2004	1	2	9	19
2005	2	5	10	16
2006	1	4	9	23
2007	1	4	10	18
2008	0	6	9	21
2009	1	5	12	20
2010	3	4	9	17

**Figure 5.5:** New RRT Rate by Age group 2001-2010

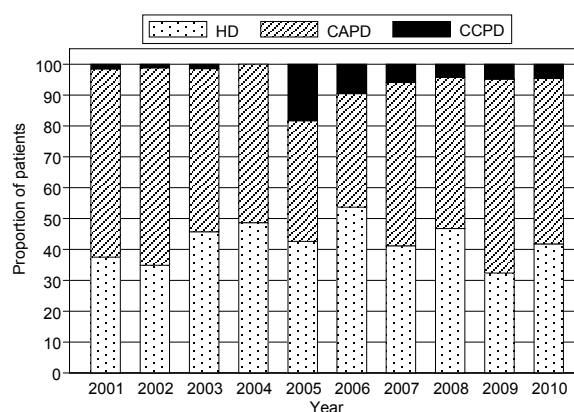


PD was the first modality of dialysis in about two thirds of patients. A significant proportion of children were previously started on automated PD (CCPD) as the first mode of dialysis in 2005 when CCPD was first made widely available to the paediatric population. However since 2009 the policy had changed back to CAPD first and the numbers on CCPD as expected showed a decreasing trend

**Table 5.6:** New Dialysis by treatment modality 2001-2010

Year	HD		CAPD		CCPD	
	n	%	n	%	n	%
2001	24	38	39	61	1	2
2002	29	35	53	64	1	1
2003	32	46	37	53	1	1
2004	39	49	41	51	0	0
2005	35	43	32	39	15	18
2006	51	54	35	37	9	9
2007	35	41	45	53	5	6
2008	44	47	46	49	4	4
2009	33	32	64	63	5	5
2010	35	41	46	54	4	5

**Figure 5.6:** New Dialysis by treatment modality 2001-2010

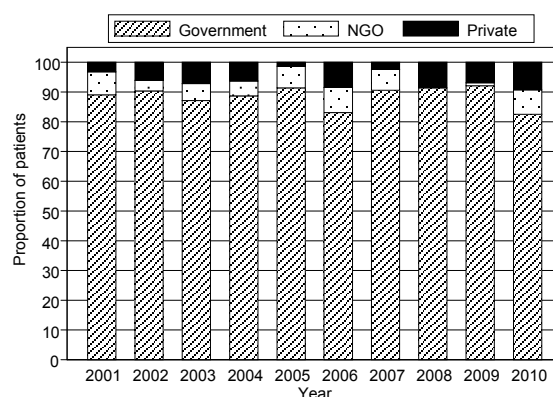


Most of the children received their dialysis treatment from government centres and hence were government funded.

**Table 5.7:** New Dialysis by sector 2001-2010

Year	Government		NGO		Private	
	n	%	n	%	n	%
2001	57	89	5	8	2	3
2002	75	90	3	4	5	6
2003	61	87	4	6	5	7
2004	71	89	4	5	5	6
2005	75	91	6	7	1	1
2006	79	83	8	8	8	8
2007	77	91	6	7	2	2
2008	86	91	0	0	8	9
2009	94	92	1	1	7	7
2010	71	84	6	7	8	9

**Figure 5.7:** New Dialysis by sector 2001-2010



## SECTION C: PRIMARY RENAL DISEASE

The most common primary renal disease identified was glomerulonephritis, which accounted for about 23% of the patients. FSGS on its own accounted for almost 8% of the ESRD population. SLE was the second commonest known cause ESRD in girls. The number of children presenting with ESRD of unknown aetiology was still high at 35%.

**Table 5.8:** Primary renal disease by sex, 2001-2010

Primary Renal Disease	Male		Female		All	
	n	%	n	%	n	%
Glomerulonephritis	106	25	66	20	172	23
FSGS	30	7	27	8	57	8
Reflux nephropathy	25	6	7	2	32	4
SLE	10	2	40	12	50	7
Obstructive uropathy	35	8	17	5	52	7
Renal dysplasia	18	4	10	3	28	4
Hereditary nephritis	14	3	3	1	17	2
Cystic kidney disease	3	1	5	2	8	1
Metabolic	4	1	3	1	7	1
Others	28	7	39	12	67	9
Unknown	156	36	112	34	268	35

## SECTION D: TYPES OF RENAL TRANSPLANTATION

Living related renal transplant used to be the commonest type of transplantation done among children. However the trend has changed particularly over the last 5 years in that cadaveric renal transplant is now the most common transplantation done accounting for about 55% compared to 27% for living related renal transplant. About 16% of renal transplant were done overseas mainly from commercial cadaveric programme.

**Table 5.9:** Types of Renal Transplantation, 2001-2010

Year	2001-2005		2006-2010	
	n	%	n	%
Commercial cadaver	17	27	14	16
Commercial living donor	3	5	1	1
Living related donor	26	42	24	27
Cadaver	16	26	50	55
Living emotionally related	0	0	1	1
TOTAL	62	100	90	100

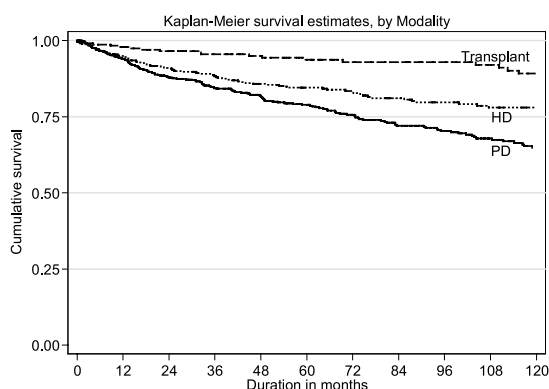
**SECTION E: SURVIVAL ANALYSIS**

Renal transplantation had the best patient survival with 94% survival at 5 years and 89% at 10 years. HD patients consistently showed better survival compared to PD patients and this disparity becomes more marked when censored for change of dialysis modality. The separation of the survival curve became more obvious after about 4 to 5 years of dialysis with PD patients showing a poorer outcome compared to HD (Figure 6.10b)

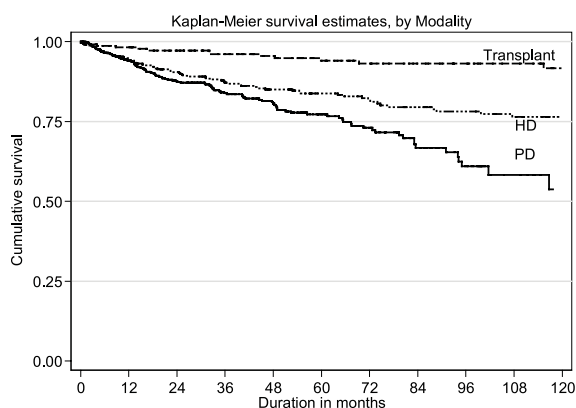
**Table 5.10 (a):** Patient survival by dialysis modality analysis (not censored with change of modality)

Modality Interval (months)	Transplant			PD			HD		
	n	% survival	SE	n	% survival	SE	n	% survival	SE
0	242	100	-	662	100	-	501	100	-
6	234	99	1	614	97	1	460	97	1
12	230	98	1	571	94	1	436	95	1
24	207	97	1	471	88	1	387	91	1
36	186	96	1	408	84	2	337	88	2
48	165	95	1	355	82	2	295	86	2
60	143	94	2	308	79	2	252	85	2
72	125	93	2	265	76	2	221	83	2
84	117	93	2	224	72	2	184	81	2
96	109	93	2	196	70	2	157	80	2
108	99	92	2	150	68	2	135	78	2
120	90	89	3	117	65	3	119	78	2

**Figure 5.10 (a):** Patient survival by dialysis modality analysis (not censored with change of modality)



**Figure 5.10 (b):** Patient survival by dialysis modality analysis (censored with change of modality)



**Table 5.10 (b):** Patient survival by dialysis modality analysis (censored with change of modality)

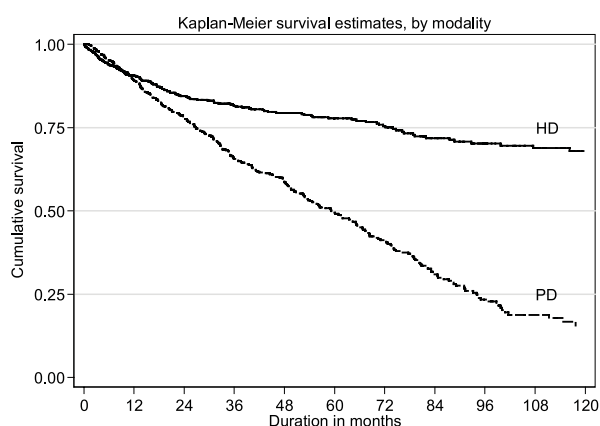
Modality Interval (months)	Transplant			PD			HD		
	n	% survival	SE	n	% survival	SE	n	% survival	SE
0	242	100	-	662	100	-	501	100	-
6	217	99	1	600	97	1	440	96	1
12	213	98	1	522	94	1	392	95	1
24	188	97	1	370	88	1	321	90	1
36	166	96	1	266	84	2	268	87	2
48	141	95	1	203	81	2	225	85	2
60	120	94	2	145	77	2	183	84	2
72	103	93	2	107	73	3	155	82	2
84	89	93	2	64	67	3	123	80	2
96	79	93	2	40	61	4	101	78	3
108	69	93	2	20	58	5	85	76	3
120	61	92	2	12	54	6	71	76	3

After the first year; dialysis technique failure rate was much higher amongst PD patients with progressive widening of the technique survival curve with increasing years on dialysis. Technique survival at 5 years was only 50% for PD compared to 78% for HD.

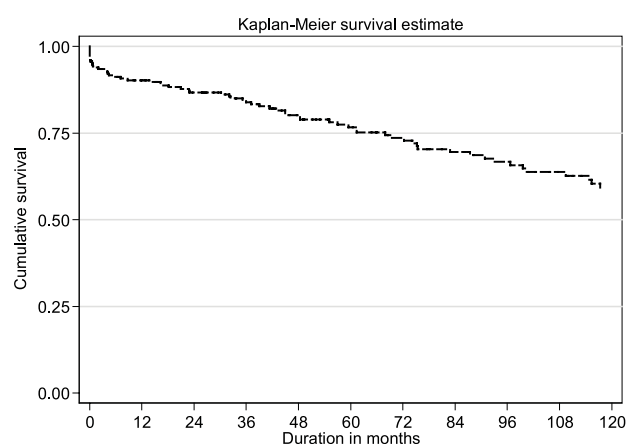
**Table 5.11:** Dialysis Technique Survival by Modality, 2001-2010

Modality Interval (months)	PD			HD		
	n	% survival	SE	n	% survival	SE
0	704	100		662	100	
6	638	95	1	580	94	1
12	558	89	1	510	91	1
24	396	78	2	407	84	2
36	283	66	2	334	82	2
48	215	59	2	277	79	2
60	153	49	2	220	78	2
72	114	41	3	188	75	2
84	69	31	3	144	72	2
96	44	23	3	117	70	2
108	23	19	3	95	69	3
120	14	16	3	75	68	3

**Figure 5.11:** Dialysis Technique Survival by Modality, 2001-2010



**Figure 5.12:** Transplant Graft Survival, 2001-2010



The graft survival for paediatric transplants was 90% at 1 year and 77% at 5 years and 59% at 10 years.

**Table 5.12:** Transplant Graft Survival, 2001-2010

Interval (month)	n	% survival	SE
0	239	100	
6	202	91	2
12	192	90	2
24	168	87	2
36	146	84	3
48	122	80	3
60	105	77	3
72	93	74	3
84	81	70	4
96	69	67	4
108	62	64	4
120	52	59	4





CHAPTER 6

**MANAGEMENT OF ANAEMIA  
IN PATIENTS ON DIALYSIS**

Philip N. Jeremiah  
Bee Boon Cheak  
Ghazali B Ahmad  
Lim Soo Kun  
Zawawi B Nordin

## SECTION 6.1: TREATMENT FOR ANAEMIA IN DIALYSIS

From 2001 – 2010, there was an increasing percentage of patients receiving erythropoietin (EPO); more haemodialysis patients were on EPO; 90% compared 78% in PD. The percentage of patients requiring blood transfusion has remained at about 14 to 16% for both HD and PD patients over the last few years despite an increasing percentage of patients on EPO.

There were a decreasing number of patients receiving oral iron. Percentage of HD patients on parenteral iron is slowly increasing, however, in PD patients, this has essentially remained the same. (Table 6.1.1 – 6.1.2)

**Table 6.1.1:** Treatment for Anaemia, HD patients 2001-2010

Year	Number of patients	% on Erythropoietin	% received blood transfusion	% on oral iron	% received parenteral iron
2001	5194	62	13	88	5
2002	6108	67	10	85	7
2003	7017	72	12	83	8
2004	8064	74	11	80	10
2005	9344	81	14	74	11
2006	11679	83	18	76	16
2007	12907	85	15	74	17
2008	15399	88	16	63	23
2009	17969	89	15	59	26
2010	19245	90	14	57	27

**Table 6.1.2:** Treatment for Anaemia, PD patients 2001-2010

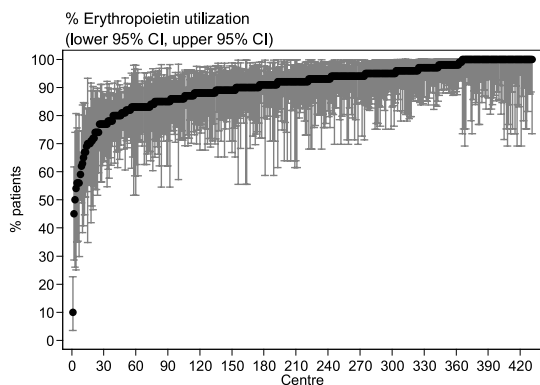
Year	Number of patients	% on Erythropoietin	% received blood transfusion	% on oral iron	% received parenteral iron
2001	781	45	11	91	2
2002	891	49	11	93	2
2003	1230	53	14	87	4
2004	1312	63	15	85	7
2005	1390	72	12	87	8
2006	1552	74	16	83	13
2007	1806	74	16	80	12
2008	2084	77	16	77	12
2009	2212	76	16	74	14
2010	2360	78	16	73	12

In 2010, the percentage of patients on EPO among the HD centres varied significantly from 10% to 100%. The median usage of EPO was 92% compared to 61% a decade ago. (Table 6.1.3)

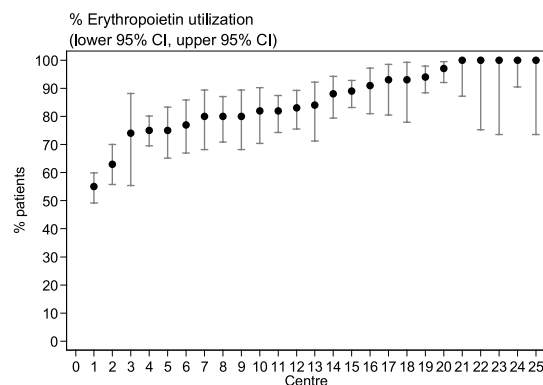
**Table 6.1.3:** Variation in Erythropoietin utilization (% patients) among HD centres, 2001-2010

Year	Number of centres	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	127	0	19	49	61	75	88	100
2002	153	14	26	56	71	79	91	100
2003	185	17	38	60	73	83	95	100
2004	215	10	39	67	77	86	100	100
2005	243	8	56	73	83	91	100	100
2006	292	3	54	79	87	93	100	100
2007	318	4	61	82	89	94	100	100
2008	369	9	61	85	91	96	100	100
2009	410	0	71	86	92	96	100	100
2010	431	10	74	87	92	96	100	100

**Figure 6.1.3:** Variation in Erythropoietin utilization (% patients) among HD centres, 2010



**Figure 6.1.4:** Variation in Erythropoietin utilization (% patients) among PD centres, 2010



In PD centres, there was a lesser variation in the EPO utilization – 55 to 100 %. The median usage of EPO was 84% in 2010. (Table 6.1.4 )

**Table 6.1.4:** Variation in Erythropoietin utilization (% patients) among PD centres, 2001-2010

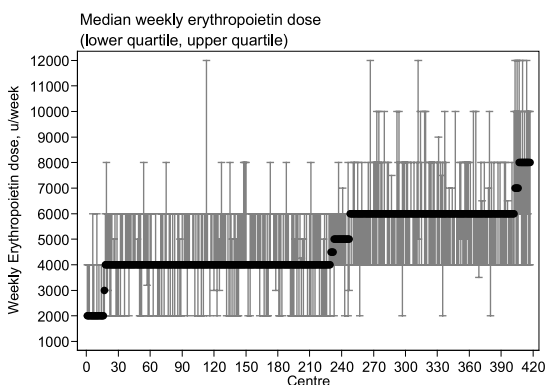
Year	Number of centres	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	12	25	25	33	47	57	87	87
2002	15	26	26	43	53	62	71	71
2003	18	25	25	38	50.5	67	92	92
2004	18	5	5	53	62.5	79	97	97
2005	19	41	41	62	69	81	97	97
2006	22	35	52	67	74	86	96	97
2007	23	0	44	64	76	90	97	100
2008	23	20	58	70	79	88	100	100
2009	23	30	56	73	83	88	100	100
2010	25	55	63	80	84	94	100	100

The median weekly EPO dose has remained at 4000 units over the last 4 years in both HD and PD centres. It is interesting to note that the maximum dose of EPO used in PD patients is only 6000 units / week and only 8000 units /week in HD patients. This varies significantly with what was reported in 2005 to 2007 in HD patients. (Table 6.1.5 and 6.1.6)

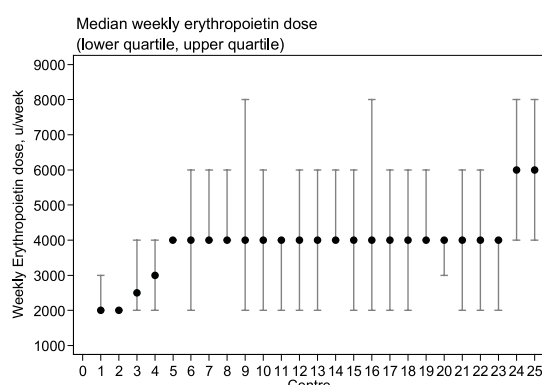
**Table 6.1.5:** Variation in median weekly Erythropoietin dose (u/week) among HD centres, 2001-2010

Year	Number of centres	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	93	2000	2000	2000	2000	2000	4000	5000
2002	117	2000	2000	2000	2000	2000	4000	6000
2003	147	2000	2000	2000	2000	2000	4000	5000
2004	180	2000	2000	2000	2000	2000	4000	5000
2005	218	2000	2000	2000	2000	4000	6000	16000
2006	277	2000	2000	4000	4000	6000	8000	24000
2007	305	2000	4000	4000	4000	6000	8000	16000
2008	359	2000	2000	4000	4000	4000	6000	9000
2009	403	2000	3000	4000	4000	6000	6000	8000
2010	417	2000	4000	4000	4000	6000	6000	8000

**Figure 6.1.5:** Variation in median weekly Erythropoietin dose (u/week) among HD centres, 2010



**Figure 6.1.6:** Variation in median weekly Erythropoietin dose (u/week) among PD centres, 2010



**Table 6.1.6:** Variation in median weekly Erythropoietin dose (u/week) among PD centres, 2001-2010

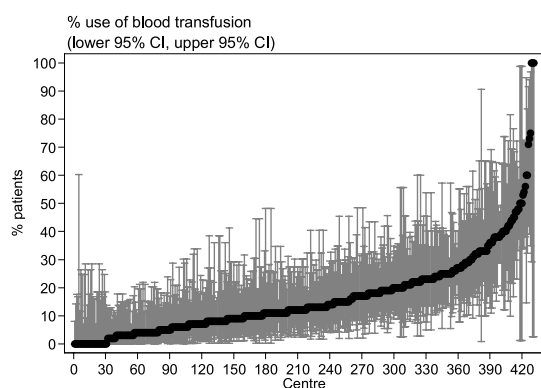
Year	Number of centres	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	11	2000	2000	2000	2000	3000	4000	4000
2002	12	2000	2000	2000	2000	2000	4000	4000
2003	16	2000	2000	2000	2000	2000	4000	4000
2004	17	2000	2000	2000	2000	2000	4000	4000
2005	18	2000	2000	2000	2000	4000	6000	6000
2006	21	2000	2000	2000	4000	4000	4500	5000
2007	22	2000	2000	4000	4000	4000	6000	8000
2008	22	2000	2000	4000	4000	4000	6000	6000
2009	22	2000	2000	4000	4000	4000	4000	4000
2010	25	2000	2000	4000	4000	4000	6000	6000

In HD centres, the median requirement of blood transfusion is slowly reducing, however, this has remained at around 16% in PD centres. (Table 6.1.7 – 6.1.8)

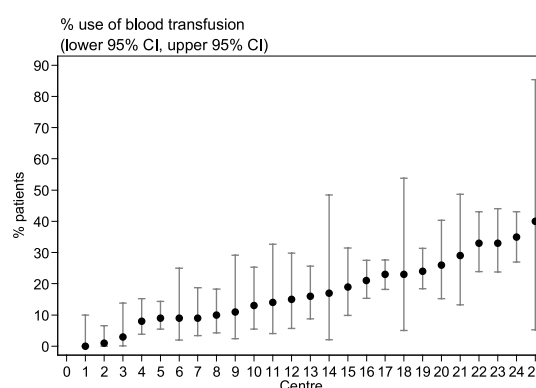
**Table 6.1.7:** Variation in use of blood transfusion (% patients) among HD centres, 2001-2010

Year	Number of centres	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	127	0	0	5	12	20	36	50
2002	153	0	0	2	8	15	28	67
2003	185	0	0	4	9	19	36	63
2004	215	0	0	2	7	17	38	48
2005	243	0	0	5	11	20	42	75
2006	292	0	2	10.5	18	29	47	89
2007	317	0	0	8	15	24	42	100
2008	368	0	0	8	17	26.5	44	100
2009	409	0	0	7	14	23	44	100
2010	431	0	0	7	12	22	44	100

**Figure 6.1.7:** Variation in use of blood transfusion (% patients) among HD centres, 2010



**Figure 6.1.8:** Variation in use of blood transfusion (% patients) among PD centres, 2010



**Table 6.1.8:** Variation in use of blood transfusion (% patients) among PD centres, 2001-2010

Year	Number of centres	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	12	0	0	0	3.5	15.5	37	37
2002	15	0	0	5	8	21	42	42
2003	18	0	0	3	10.5	21	59	59
2004	18	0	0	7	15	20	37	37
2005	19	0	0	4	11	17	44	44
2006	22	0	3	9	16.5	27	36	47
2007	23	6	7	11	18	24	33	36
2008	23	2	4	7	15	28	35	40
2009	23	0	3	9	16	26	32	36
2010	25	0	1	9	16	24	35	40

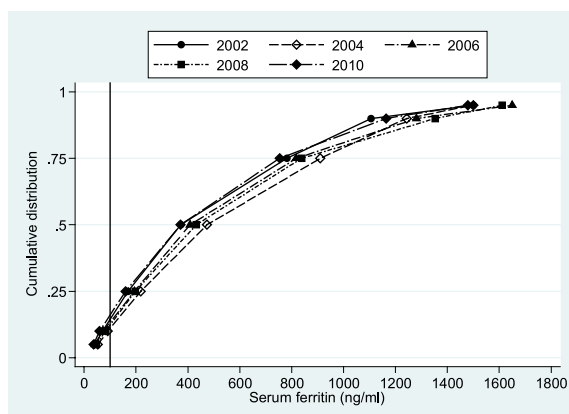
## SECTION 6.2: IRON STATUS ON DIALYSIS

In HD and PD patients with or without EPO, the mean and median serum Ferritin has remained stable over the years – 400 to 700 ng/ml. Up to 97% of patients have serum ferritin of greater 100 ng/ml. It appears that PD patients, with or without EPO have consistently shown higher Ferritin level than HD patients. (Table 6.2.1 – 6.2.4)

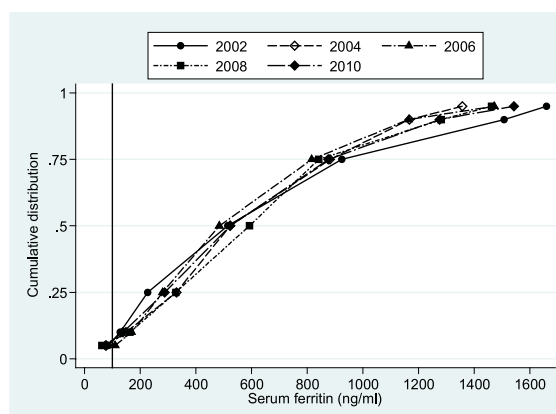
**Table 6.2.1:** Distribution of Serum Ferritin without Erythropoietin, HD patients 2001-2010

Year	Number of patients	Mean	SD	Median	LQ	UQ	% Patients $\geq 100$ ng/ml
2001	758	537.6	453.9	383.5	172	828	87
2002	803	519.5	447.3	373	168.5	781	85
2003	916	551.5	434.2	456.7	190	827.7	87
2004	1042	590.7	463.6	473.5	218	910.5	89
2005	1010	618.5	498.7	485.5	225	902	90
2006	1169	562.4	485.6	408	193.8	817.5	87
2007	1182	586.0	501.0	431	196	860.9	86
2008	1186	578.0	489.9	431.9	197	838.1	87
2009	1283	546.6	461.7	419.7	171	798	87
2010	1360	508.6	453.1	371.4	159.6	753.3	83

**Figure 6.2.1:** Cumulative Distribution of Serum Ferritin without Erythropoietin, HD patients 2001-2010



**Figure 6.2.2:** Distribution of Serum Ferritin without Erythropoietin, PD patients 2001-2010



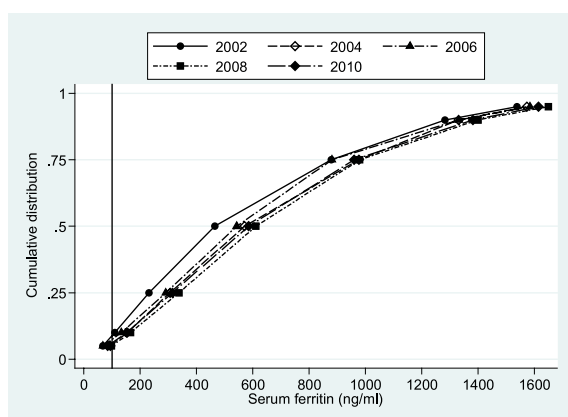
**Table 6.2.2:** Distribution of Serum Ferritin without Erythropoietin, PD patients 2001-2010

Year	Number of patients	Mean	SD	Median	LQ	UQ	% Patients $\geq 100$ ng/ml
2001	223	543.8	417.5	440	216.9	754	91
2002	236	634.8	491.2	514.9	226	924.6	93
2003	329	602.5	429.2	503.7	269	834	93
2004	303	608.4	385.7	522.7	330	882	94
2005	225	651.4	397.8	609	324	913.3	96
2006	263	589.9	411.3	484	280	815.8	95
2007	305	636.9	396.6	582.3	342.8	841.9	96
2008	338	634	410.1	592	327.4	841	93
2009	364	621.6	401.1	553	322.5	861.8	95
2010	382	624.9	446.6	523.5	287.4	875.8	93

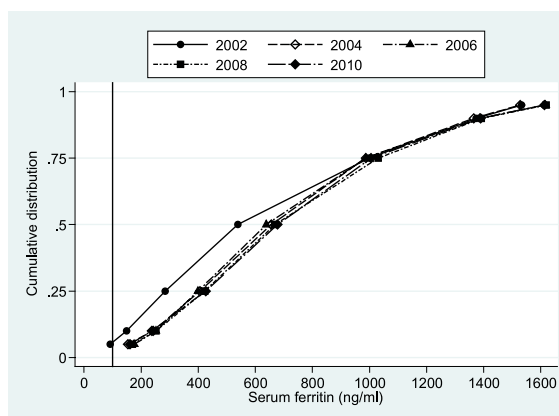
**Table 6.2.3:** Distribution of Serum Ferritin on Erythropoietin, HD patients 2001-2010

Year	Number of patients	Mean	SD	Median	LQ	UQ	% Patients $\geq 100$ ng/ml
2001	1637	597.5	444.2	491	236	894.2	91
2002	2224	593.1	459.3	464.8	231.3	878.2	91
2003	3134	640.8	428.1	563.3	298	931	94
2004	3904	669.7	460.4	571	306	976.5	94
2005	5116	682.7	471	599.5	315.3	971.5	93
2006	6765	640.3	459	543	291.2	881	93
2007	8032	658.8	452.2	564.4	315.5	914	94
2008	9936	703.6	469.3	611	337.5	979.6	95
2009	12237	679.3	459.5	596	319.5	941.9	94
2010	13444	681.9	470	585.5	314.5	960	94

**Figure 6.2.3:** Cumulative distribution of Serum Ferritin on Erythropoietin, HD patients 2001-2010



**Figure 6.2.4:** Cumulative distribution of Serum Ferritin on Erythropoietin, PD patients 2001-2010



**Table 6.2.4:** Distribution of Serum Ferritin on Erythropoietin, PD patients 2001-2010

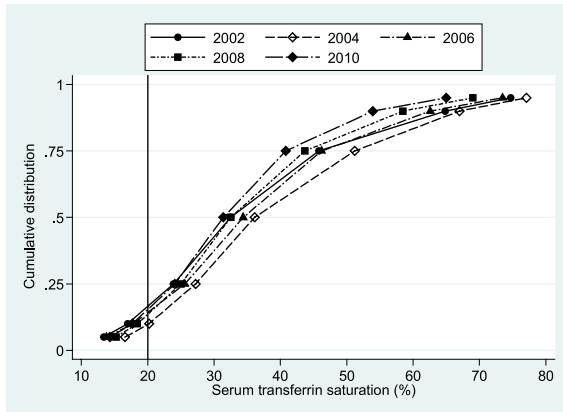
Year	Number of patients	Mean	SD	Median	LQ	UQ	% Patients $\geq 100$ ng/ml
2001	261	645.9	449.2	557.5	275.7	885.4	93
2002	345	666.8	462.4	538.5	284	999.5	94
2003	517	689.9	459.9	589	304	993.2	96
2004	540	728.8	427.2	655.6	406.3	986.7	98
2005	767	732.9	433.6	659	403.6	997.5	97
2006	888	729.9	435.6	638.4	399.5	986.2	98
2007	1091	741.3	426.1	652	423.8	1015	98
2008	1310	758.4	445.4	668.6	422.4	1030.3	98
2009	1390	759.5	438.7	689	421.1	1017.5	98
2010	1554	753.3	438	677.1	426.3	1005.5	97

The median transferrin saturation has remained the same over the last decade, with the mean and median always greater than 30%. In 2010, up to 91% of all patients have transferrin saturation greater than 20% (Table 6.2.5 – 6.2.8)

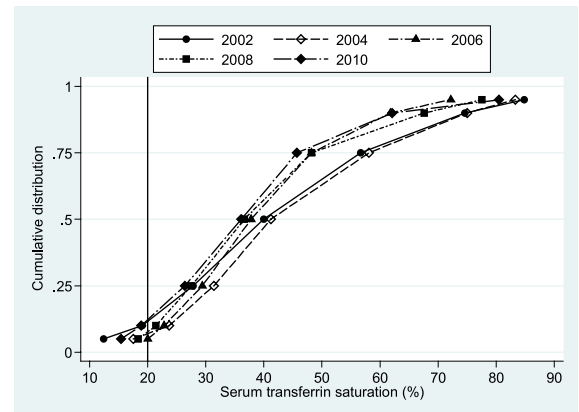
**Table 6.2.5:** Distribution of transferrin saturation without Erythropoietin, HD patients, 2001-2010

Year	Number of patients	Mean	SD	Median	LQ	UQ	% Patients $\geq 20$ %
2001	836	36.9	18.5	32.5	23.9	45.8	84
2002	811	36.5	18.9	32	22.9	45.7	83
2003	922	40.3	18.6	36.1	27.2	51.2	91
2004	1031	41.2	18.1	37.5	28.5	50.1	92
2005	1106	37.7	17.8	34.4	25.6	46.2	87
2006	1149	36.2	16.9	32.9	24.7	44.2	87
2007	1206	36.1	16.5	32.5	25	43.7	87
2008	1211	34.3	15.5	31.8	23.7	41.4	85
2009	1282	34.3	15.9	31.4	24.1	40.8	85
2010	1412	33.5	15.5	30.5	22.8	40.3	83

**Figure 6.2.5:** Cumulative distribution of transferrin saturation without Erythropoietin, HD patients 2001-2010



**Figure 6.2.6:** Cumulative distribution of transferrin saturation without Erythropoietin, PD patients 2001-2010



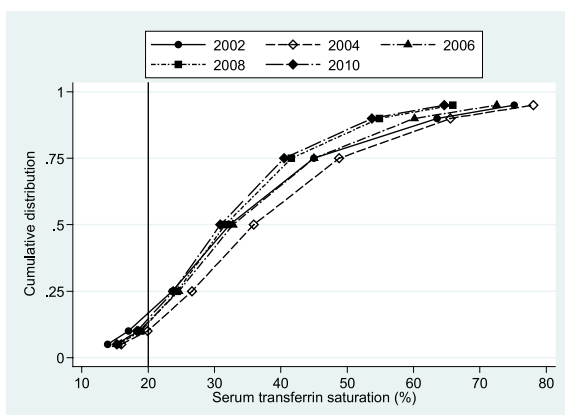
**Table 6.2.6:** Distribution of transferrin saturation without Erythropoietin, PD patients, 2001-2010

Year	Number of patients	Mean	SD	Median	LQ	UQ	% Patients ≥20 %
2001	279	43.2	20.8	40	27.8	56.7	89
2002	332	42.7	19.1	38.1	28.3	54.5	92
2003	397	45.2	19.7	41.2	31.4	58.1	93
2004	379	44.5	18.2	41.6	30.9	55.5	98
2005	287	40.6	16.2	37.8	29.4	48.2	95
2006	299	40.5	17.4	37.9	27.3	47.3	95
2007	348	40.3	17.9	36.6	27.5	48.2	92
2008	349	38.2	17.8	34.3	26.2	44.4	91
2009	439	38.4	18.2	36.1	26.4	45.7	87
2010	441	38.3	17.8	35.1	25.9	45.3	89

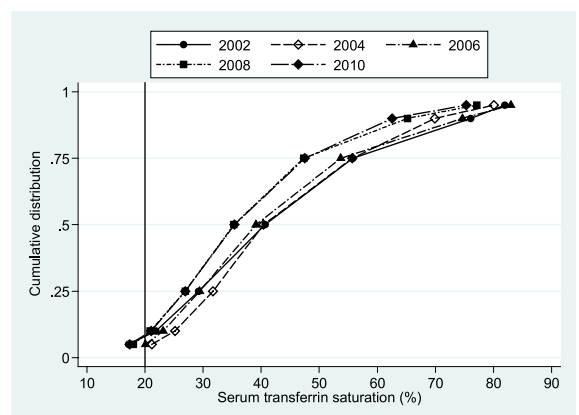
**Table 6.2.7:** Distribution of Transferrin saturation on Erythropoietin, HD patients, 2001-2010

Year	Number of patients	Mean	SD	Median	LQ	UQ	% Patients ≥20 %
2001	1634	36.2	17.9	32.3	23.6	45	84
2002	1995	34.6	17.6	30.6	22.2	43.6	81
2003	2641	39.6	18.4	35.9	26.6	48.8	90
2004	3269	39.6	17	36.1	27.8	48.1	93
2005	4808	36.6	17.2	32.8	24.6	45	87
2006	6384	35.1	16.4	31.6	24.1	42.1	87
2007	7604	34.7	15.4	31.6	24.4	41.6	88
2008	9535	34.7	15.4	31.5	24	41.6	87
2009	11851	34	15.4	30.9	23.8	40.5	86
2010	13615	34	15.1	30.9	24.2	40.3	87

**Figure 6.2.7:** Cumulative distribution of transferrin saturation on Erythropoietin, HD patients 2001-2010



**Figure 6.2.8:** Cumulative distribution of transferrin saturation on Erythropoietin, PD patients 2001-2010





**Table 6.2.8:** Distribution of Transferrin saturation on Erythropoietin, PD patients, 2001-2010

Year	Number of patients	Mean	SD	Median	LQ	UQ	% Patients ≥20 %
2001	292	44.1	19.6	40.7	29.2	55.8	94
2002	363	43.6	18.6	39.7	30	54.3	94
2003	460	44.6	17.8	40.4	31.7	55.7	96
2004	697	44.7	18.7	40.8	30.8	54.5	96
2005	820	43.5	19.3	39.1	29.4	53.7	95
2006	916	41.6	17.5	38	29.4	50.7	95
2007	1080	39.3	17.6	35.3	26.9	47.3	92
2008	1265	38.6	17.9	34.4	26.2	47.1	91
2009	1550	39.1	17.3	35.4	26.9	47.5	92
2010	1628	38.9	17.5	35.5	26.7	47.3	91

From 2001 to 2010, the median for ferritin for all HD centres has remained at 500 to 600 ng/ml. There was a wide variation in ferritin levels ranging from 37 to 1236 ng/ml between HD centres in 2010. At the median, 96% of patients on EPO have a serum ferritin greater 100 ng/ml. The median transferrin saturation has been > 30% over the last 10 years. 89% of patients on HD have transferrin saturation greater than 20%. (Table 6.2.9)

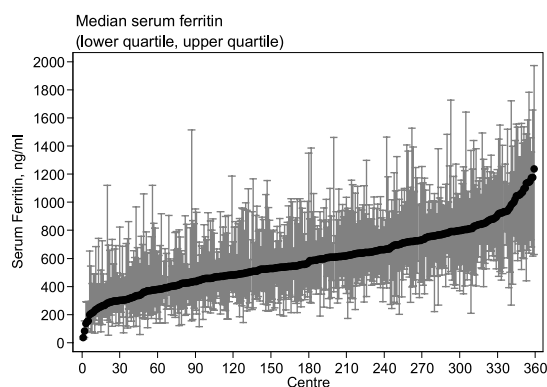
A similar trend, but with higher level of ferritin and transferrin saturation was seen in the PD centres. (Table 6.2.10)

**Table 6.2.9:** Variation in iron status outcomes among HD centres, 2001-2010

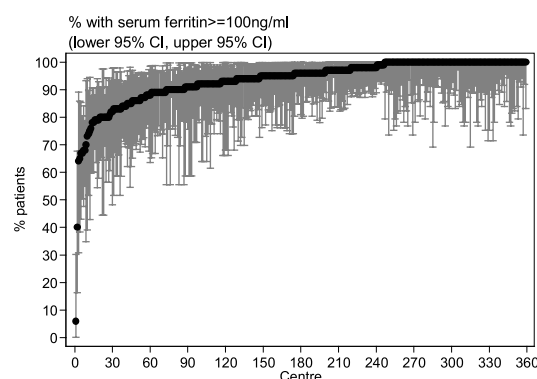
a) Medium serum ferritin among patients on erythropoietin

Year	Number of centres	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	51	213.8	239.3	360.5	508	670	886.5	1225
2002	68	106.6	193.9	369.5	478.7	610	836.5	1031
2003	101	152.5	317.8	463	554	692	950.1	1742.8
2004	124	99.5	328.5	450.3	569.3	736.4	991.8	2000
2005	161	1.6	307	463	625.3	734	950.8	2000
2006	209	1.5	237	413.4	554.8	691.3	867	2000
2007	241	92.7	259	439	561.7	689.8	874.5	1408
2008	281	9;2.2	316	487	601	709	922.6	2000
2009	337	101.7	298.8	452.3	594	719.5	898.7	1473
2010	359	37.3	265	435.8	575	733.8	991.8	1236.5

**Figure 6.2.9(a):** Variation in medium serum ferritin among patients on erythropoietin, HD centres 2010



**Figure 6.2.9(b):** Variation in proportion of patients on erythropoietin with serum ferritin ≥ 100 ng/ml, HD centres 2010



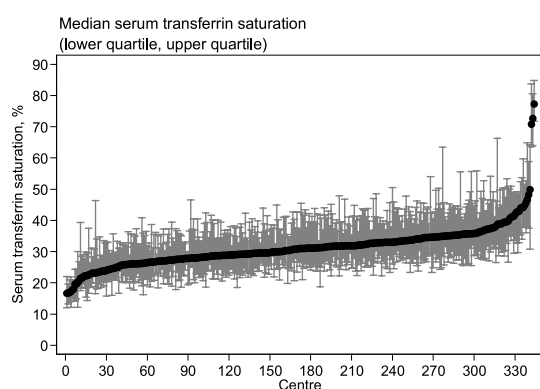
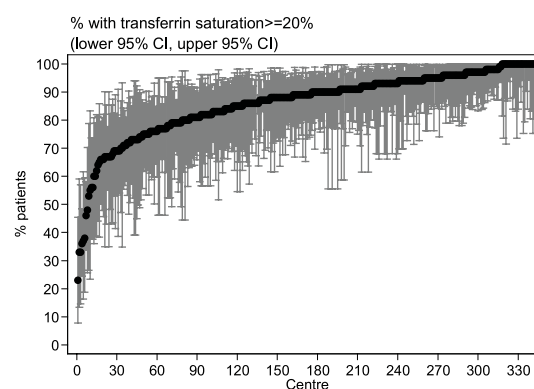
b) Proportion of patients on erythropoietin with serum ferritin  $\geq 100$  ng/ml, HD centres

Year	Number of centres	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	51	71	71	88	93	96	100	100
2002	68	55	73	88.5	93	96.5	100	100
2003	101	57	76	91	96	100	100	100
2004	124	50	85	92	96	100	100	100
2005	161	5	79	91	95	100	100	100
2006	209	0	74	91	95	100	100	100
2007	241	44	78	92	96	100	100	100
2008	281	47	81	92	96	100	100	100
2009	337	50	81	91	95	100	100	100
2010	359	6	79	91	96	100	100	100

## c) Median transferrin saturation among patients on erythropoietin, HD centres

Year	Number of centres	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	54	21	22.6	26.8	31.3	36.8	48.1	76.1
2002	61	14.1	21.2	26	29.5	35.6	50.8	60.2
2003	91	18.2	24.2	30.8	34.4	41.1	55.6	70.7
2004	115	22.7	26.8	33	35.9	41.5	52	66.8
2005	147	15.2	25.1	29.2	32.5	37.1	47.1	69.8
2006	186	13.7	22.4	27.8	31.4	35.8	45.4	81.3
2007	217	17.4	22	27.7	31.4	35.1	42.5	78.1
2008	259	16.5	23.4	28	31.9	34.5	46.5	76
2009	309	16.9	21.7	27.4	30.3	34	42.6	79.8
2010	344	16.6	22.6	27.7	31	34	40.9	77.2

Figure 6.2.9(c): Variation in median transferrin saturation among patients on erythropoietin HD centres, 2010

Figure 6.2.9(d): Variation in proportion of patients on erythropoietin with transferrin saturation  $\geq 20\%$ , HD centres, 2010d) Proportion of patients on erythropoietin with transferrin saturation  $\geq 20\%$ , HD centres

Year	Number of centres	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	54	57	60	76	88.5	96	100	100
2002	61	32	58	69	82	92	100	100
2003	91	45	68	86	93	100	100	100
2004	115	55	73	90	94	100	100	100
2005	150	30	70	83	91	95	100	100
2006	187	20	60	80	90	95	100	100
2007	219	27	62	83	91	96	100	100
2008	262	13	68	81	90	95	100	100
2009	314	35	62	80	88	94	100	100
2010	344	23	66	81	89	94	100	100

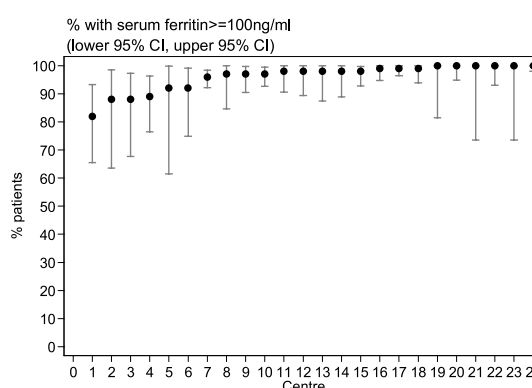
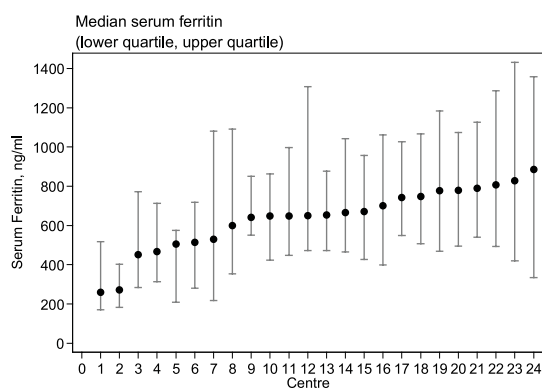
**Table 6.2.10:** Variation in iron status outcomes among PD centres, 2001-2010

a) Medium serum ferritin among patients on erythropoietin

Year	Number of centres	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	9	285.8	285.8	532.8	550.7	617.5	908	908
2002	10	372.2	372.2	437.4	477	606.5	826.5	826.5
2003	12	304	304	454.5	508.5	716.1	954.9	954.9
2004	13	317	317	529.5	610	701.3	860.3	860.3
2005	17	338.5	338.5	557.2	709.9	800.9	843	843
2006	19	391.2	391.2	531	619.3	788.5	968.4	968.4
2007	21	290.3	313.4	592	636.2	716.3	961.7	1048.6
2008	21	309.5	381.3	494.3	656.3	801.8	970.1	991.5
2009	21	291.3	341.3	555.5	679.1	795.3	947	1233.3
2010	24	260.4	272.3	521.5	651.3	762.2	827.5	886.2

**Figure 6.2.10(a):** Variation in medium serum ferritin among patients on erythropoietin, PD centres 2010

**Figure 6.2.10(b):** Variation in proportion of patients on erythropoietin with serum ferritin ≥ 100ng/ml, PD centres 2010

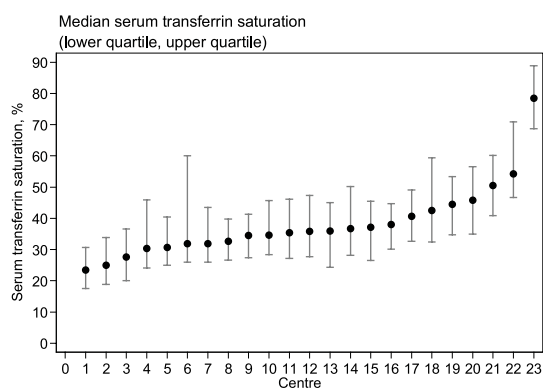
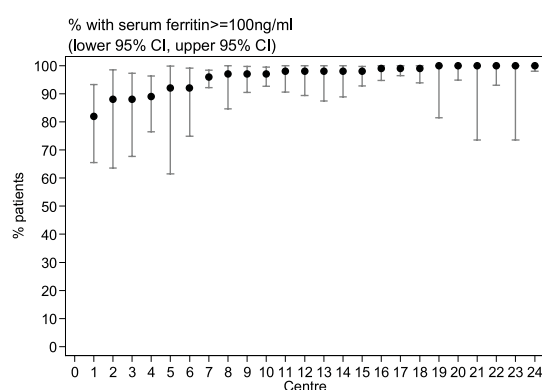


b) Proportion of patients on erythropoietin with serum ferritin ≥ 100 ng/ml, PD centres

Year	Number of centres	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	9	80	80	85	94	100	100	100
2002	10	91	91	92	94.5	100	100	100
2003	12	85	85	95	96	98	100	100
2004	13	93	93	95	100	100	100	100
2005	17	86	86	96	97	100	100	100
2006	19	95	95	97	100	100	100	100
2007	21	90	90	96	98	100	100	100
2008	21	87	88	93	98	100	100	100
2009	21	83	85	95	98	100	100	100
2010	24	82	88	94	98	99.5	100	100

c) Median transferrin saturation among patients on erythropoietin, PD centres

Year	Number of centres	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	8	28.4	28.4	31.9	36.9	47.5	79.8	79.8
2002	9	30.5	30.5	36.5	38.6	40.3	60.4	60.4
2003	13	31.9	31.9	35.8	41.5	47.5	64	64
2004	17	29.1	29.1	36	40.9	42.7	82.3	82.3
2005	17	30.3	30.3	35.9	38.5	43	76.4	76.4
2006	19	30.1	30.1	34.6	37.7	40.2	75.8	75.8
2007	19	25.9	25.9	29.6	37.7	46.3	83	83
2008	19	25.2	25.2	31.6	34.2	42.9	81.1	81.1
2009	21	25	27.5	32.8	37.9	40	55.4	83.4
2010	23	23.5	25	31.9	35.9	42.5	54.2	78.5

**Figure 6.2.10 (c):** Variation in median transferrin saturation among patients on erythropoietin, PD centres 2010**Figure 6.2.10 (d):** Variation in proportion of patients on erythropoietin with transferrin saturation  $\geq 20\%$ , PD centres 2010**d) Proportion of patients on erythropoietin with transferrin saturation  $\geq 20\%$ , PD centres**

Year	Number of centres	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	8	85	85	92	93.5	95.5	97	97
2002	9	78	78	92	93	98	100	100
2003	13	90	90	95	96	100	100	100
2004	17	88	88	96	97	100	100	100
2005	17	88	88	93	97	100	100	100
2006	19	83	83	94	95	98	100	100
2007	19	75	75	88	94	98	100	100
2008	19	65	65	92	95	96	100	100
2009	21	70	81	91	95	98	100	100
2010	23	70	70	90	95	100	100	100

### SECTION 6.3: HAEMOGLOBIN OUTCOMES ON DIALYSIS

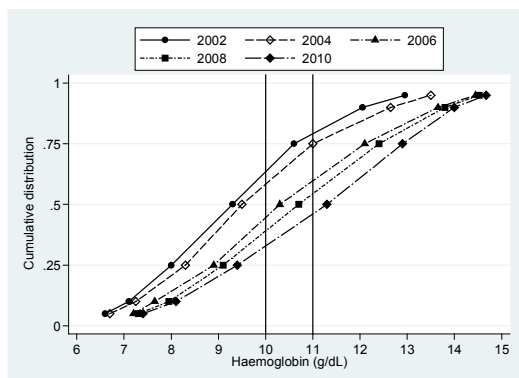
The mean and median haemoglobin concentrations in all dialysis patients with or without EPO remained the same.

In 2010 the mean and median haemoglobin ranged from 10.3 to 11.4g/dl for all dialysis patients. The percentage of patients with haemoglobin > 10 or > 11 gm/dl steadily increased for HD patients not on EPO; the Hb is otherwise static for all other patients. In 2010, the median hemoglobin achieved in HD and PD patients is the same at 10.4g/dl. This is despite of higher use of EPO and parenteral iron in HD patients. (Table 6.3.1 – 6.3.4)

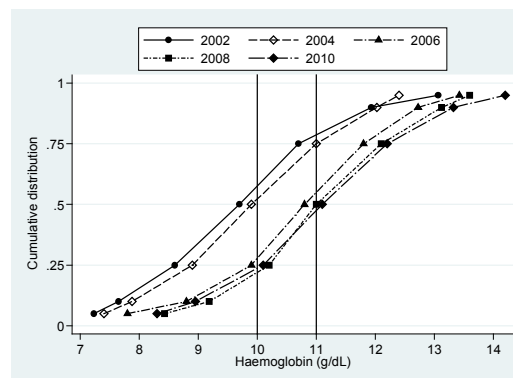
**Table 6.3.1:** Distribution of Haemoglobin Concentration without Erythropoietin, HD patients 2001-2010

Year	Number of patients	Mean	SD	Median	LQ	UQ	% Patients ≤10g/dL	% Patients >10g/dL	% Patients ≤11g/dL	% Patients >11g/dL
2001	1809	9.4	1.9	9.3	8	10.6	64	36	81	19
2002	1795	9.6	2.1	9.4	8.1	10.9	62	38	76	24
2003	1801	9.7	2.1	9.5	8.3	11	60	40	75	25
2004	1925	10.1	2.2	9.9	8.6	11.5	53	47	68	32
2005	1667	10.5	2.3	10.3	8.9	12.1	46	54	62	38
2006	1760	10.6	2.2	10.5	9	12.1	42	58	59	41
2007	1756	10.8	2.2	10.7	9.1	12.4	40	60	54	46
2008	1751	10.8	2.3	10.8	9.1	12.6	39	61	54	46
2009	1847	11.2	2.3	11.3	9.4	12.9	33	67	46	54
2010	1835	11.2	2.2	11.4	9.6	12.9	29	71	43	57

**Figure 6.3.1:** Cumulative distribution of haemoglobin concentration without Erythropoietin, HD patients 2001-2010



**Figure 6.3.2:** Cumulative distribution of haemoglobin concentration without Erythropoietin, PD patients 2001-2010

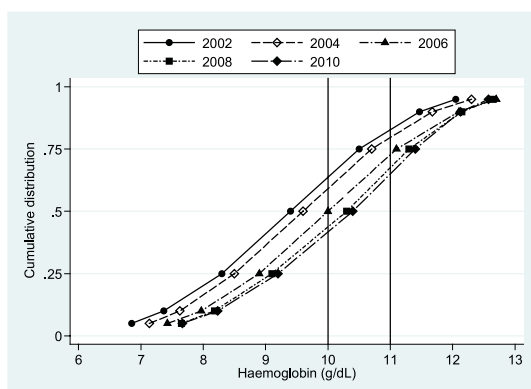
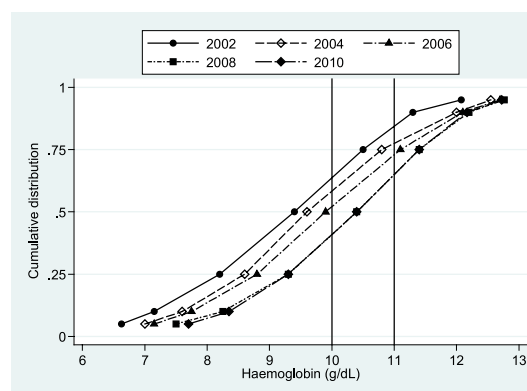


**Table 6.3.2:** Distribution of Haemoglobin Concentration without Erythropoietin, PD patients 2001-2010

Year	Number of patients	Mean	SD	Median	LQ	UQ	% Patients ≤10g/dL	% Patients >10g/dL	% Patients ≤11g/dL	% Patients >11g/dL
2001	405	9.8	1.8	9.7	8.6	10.7	59	41	78	22
2002	434	10	1.8	9.9	8.8	11	54	46	76	24
2003	542	10	1.7	9.9	8.9	11	52	48	76	24
2004	481	10.4	1.6	10.3	9.4	11.4	42	58	67	33
2005	375	10.8	1.6	10.8	9.9	11.8	28	72	60	40
2006	387	10.9	1.6	10.9	10	11.8	25	75	54	46
2007	436	11.1	1.6	11	10.2	12.1	22	78	50	50
2008	450	11.1	1.7	11.1	10.2	12.1	21	79	46	54
2009	488	11.1	1.8	11.1	10.1	12.2	25	75	48	52
2010	495	11.1	1.7	11.1	9.9	12.2	27	73	48	52

**Table 6.3.3:** Distribution of Haemoglobin Concentration on Erythropoietin, HD patients 2001-2010

Year	Number of subject	Mean	SD	Median	LQ	UQ	% Patients $\leq 10\text{g/dL}$	% Patients $>10\text{g/dL}$	% Patients $\leq 11\text{g/dL}$	% Patients $>11\text{g/dL}$
2001	3049	9.4	1.6	9.4	8.3	10.5	65	35	85	15
2002	3859	9.5	1.7	9.5	8.4	10.7	62	38	81	19
2003	4783	9.6	1.6	9.6	8.5	10.7	61	39	81	19
2004	5806	9.8	1.6	9.9	8.8	10.9	54	46	77	23
2005	7218	10	1.6	10	8.9	11.1	50	50	73	27
2006	9415	10.1	1.6	10	9	11.1	50	50	72	28
2007	10696	10.2	1.5	10.3	9.1	11.3	44	56	69	31
2008	13034	10.2	1.5	10.3	9.1	11.3	44	56	69	31
2009	15528	10.3	1.5	10.4	9.2	11.4	42	58	67	33
2010	16875	10.3	1.5	10.4	9.3	11.4	40	60	65	35

**Figure 6.3.3:** Cumulative distribution of Haemoglobin Concentration on Erythropoietin, HD patients 2001-2010**Figure 6.3.4:** Cumulative distribution of Haemoglobin Concentration on Erythropoietin, PD patients 2001-2010**Table 6.3.4:** Distribution of Haemoglobin Concentration on Erythropoietin, PD patients 2001-2010

Year	Number of subject	Mean	SD	Median	LQ	UQ	% Patients $\leq 10\text{g/dL}$	% Patients $>10\text{g/dL}$	% Patients $\leq 11\text{g/dL}$	% Patients $>11\text{g/dL}$
2001	345	9.3	1.6	9.4	8.2	10.5	65	35	86	14
2002	432	9.4	1.6	9.3	8.4	10.4	69	31	83	17
2003	639	9.7	1.7	9.6	8.6	10.8	59	41	78	22
2004	798	9.8	1.7	9.8	8.6	11	54	46	76	24
2005	970	9.9	1.7	9.9	8.8	11.1	53	47	73	27
2006	1118	10	1.6	10.1	9	11.1	50	50	74	26
2007	1319	10.3	1.6	10.4	9.3	11.4	42	58	66	34
2008	1577	10.3	1.5	10.4	9.4	11.3	39	61	66	34
2009	1664	10.3	1.5	10.4	9.3	11.4	40	60	65	35
2010	1805	10.3	1.5	10.4	9.3	11.4	42	58	67	33

In 2010, for HD patients on EPO, the median Hb in HD centres ranged 7.9 to 12.1 gm/dl with the median at 10.4 gm/dl. A similar trend is noted in PD centres with a significantly lesser variation.

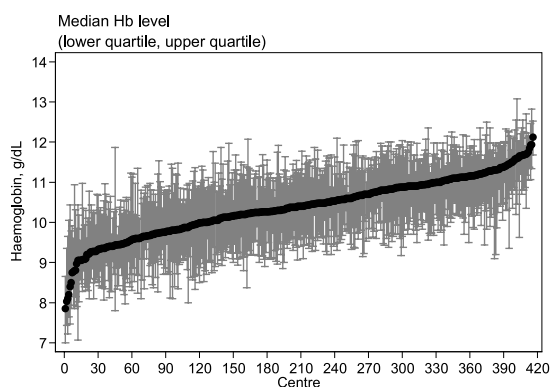
In 2010 for HD patients on EPO, the proportion of patients with Hb  $> 11$  gm/dl varied between 0 to 97%, with median at 33%. As expected, a lesser variation was seen in the PD patients.

**Table 6.3.5:** Variation in Haemoglobin outcomes among HD centres 2001-2010

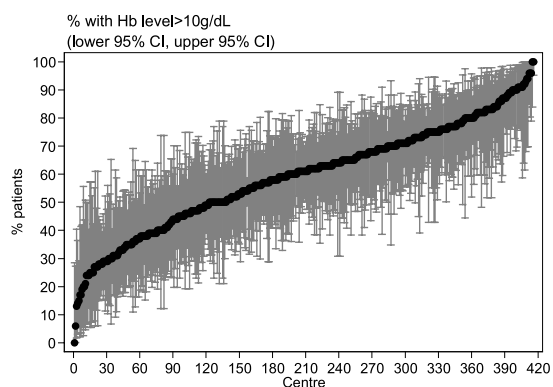
a) Median haemoglobin level among patients on Erythropoietin

Year	Number of centres	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	91	7.9	8.3	8.9	9.5	9.9	10.6	11
2002	111	7.9	8.5	9	9.4	10	10.8	11.6
2003	142	7.9	8.6	9.1	9.6	10	10.6	11.5
2004	179	7.7	8.6	9.2	9.7	10.3	10.9	11.3
2005	213	8.3	8.8	9.5	10	10.4	11.1	11.8
2006	273	7.7	8.8	9.5	9.9	10.4	11.3	12.8
2007	304	8.6	9.1	9.8	10.2	10.6	11.3	12.4
2008	356	8.2	9	9.8	10.2	10.7	11.4	12.2
2009	398	8.5	9.1	9.9	10.3	10.8	11.4	12.2
2010	416	7.9	9.2	9.9	10.4	10.9	11.5	12.1

**Figure 6.3.5(a):** Variation in median haemoglobin level among patients on Erythropoietin, HD centres 2010



**Figure 6.3.5(b):** Variation in proportion of patients on erythropoietin with haemoglobin level > 10g/dL, HD centres 2010



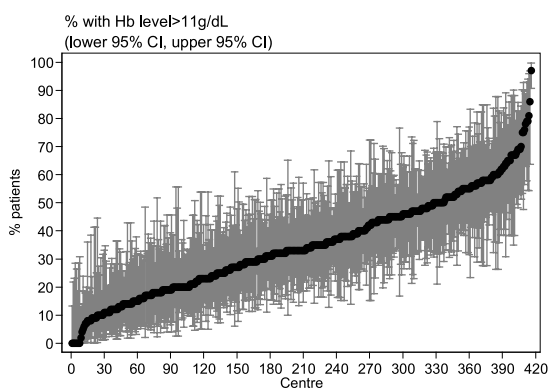
b) Proportion of patients on erythropoietin with haemoglobin level > 10g/dL, HD centres

Year	Number of centres	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	91	4	10	23	33	47	67	71
2002	111	0	14	27	35	48	64	87
2003	142	7	14	27	37	50	66	90
2004	179	9	17	30	42	57	76	89
2005	213	0	20	33	49	61	78	100
2006	273	0	18	36	47	62	81	95
2007	304	13	26	42	55	68	83	100
2008	356	0	27	43	57	69.5	82	100
2009	398	7	27	46	58	70	86	100
2010	416	0	27	46	61	73	89	100

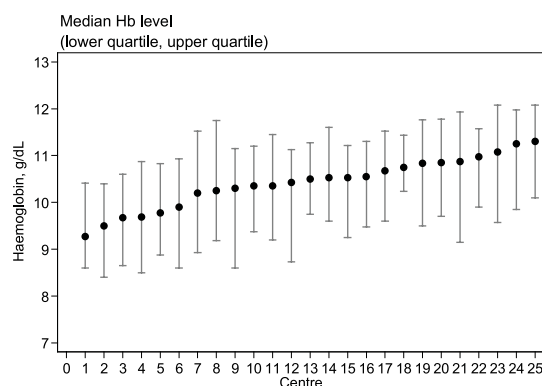
c) Proportion of patients on erythropoietin with haemoglobin level > 11g/dL, HD centres

Year	Number of centres	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	91	0	0	8	13	24	33	50
2002	111	0	4	12	17	27	43	67
2003	142	0	0	8	15	27	41	56
2004	179	0	0	10	19	30	47	58
2005	213	0	4	13	25	35	53	83
2006	273	0	6	17	25	37	58	73
2007	304	0	8	19	27	40	61	92
2008	356	0	8	20.5	30	41	60	100
2009	398	0	9	21	31	44	62	81
2010	416	0	9	20	33	47	65	97

**Figure 6.3.5(c):** Variation in proportion of patients on erythropoietin with haemoglobin level > 11g/dL, HD centres 2010



**Figure 6.3.6(a):** Variation in median haemoglobin level among patients on Erythropoietin, PD centres 2010



**Table 6.3.6:** Variation in Haemoglobin outcomes among PD centres 2001-2010

a) Median haemoglobin level among patients on Erythropoietin

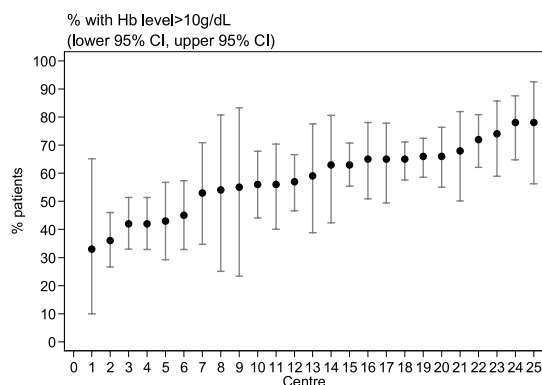
Year	Number of centres	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	11	9	9	9.2	9.4	9.6	9.7	9.7
2002	12	8.6	8.6	9.1	9.3	9.5	9.9	9.9
2003	16	8.4	8.4	9.3	9.5	10	11.2	11.2
2004	17	8.4	8.4	9.2	9.7	10.2	11.2	11.2
2005	18	8.9	8.9	9.6	9.9	10.3	11	11
2006	22	8.8	8.8	9.5	9.9	10.4	10.6	10.9
2007	22	9.5	9.5	10.1	10.3	10.8	11.1	11.1
2008	22	9.2	9.6	10.2	10.4	10.8	11.1	11.2
2009	22	9.2	9.4	9.9	10.5	10.7	11.1	11.2
2010	25	9.3	9.5	10.2	10.5	10.8	11.3	11.3



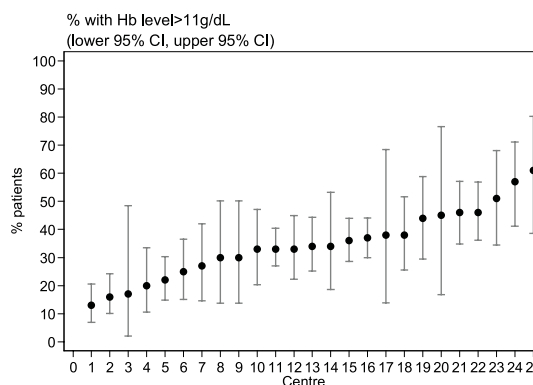
b) Proportion of patients on erythropoietin with haemoglobin level > 10g/dL, PD centres

Year	Number of centres	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	11	25	25	31	38	42	47	47
2002	12	11	11	25	32	37.5	48	48
2003	16	0	0	28.5	35.5	50	75	75
2004	17	10	10	38	43	55	72	72
2005	18	21	21	35	46	56	76	76
2006	22	16	19	43	48	58	70	80
2007	22	35	36	52	59.5	63	72	72
2008	22	31	36	53	60	65	75	89
2009	22	31	37	49	59.5	65	75	76
2010	25	33	36	53	59	66	78	78

**Figure 6.3.6(b):** Variation in proportion of patients on erythropoietin with haemoglobin level > 10g/dL, PD centres, 2010



**Figure 6.3.6(c):** Variation in proportion of patients on erythropoietin with haemoglobin level > 11g/dL, PD centres 2010



c) Proportion of patients on erythropoietin with haemoglobin level > 11g/dL, PD centres

Year	Number of centres	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	11	8	8	10	16	20	23	23
2002	12	7	7	13	17.5	22	27	27
2003	16	0	0	12	15.5	22.5	52	52
2004	17	0	0	13	20	29	54	54
2005	18	7	7	21	29.5	34	51	51
2006	22	0	5	16	25.5	33	38	48
2007	22	13	14	22	34.5	44	52	53
2008	22	11	15	23	34	44	54	60
2009	22	13	18	31	36	43	51	51
2010	25	13	16	27	34	44	57	61

# CHAPTER 7

## **NUTRITIONAL STATUS ON DIALYSIS**

Winnie Chee Siew Swee  
Abdul Halim B Abd Gafor  
Ahmad Fauzi B Abd Rahman  
Koh Keng Hee  
Tilakavati Karupaiah

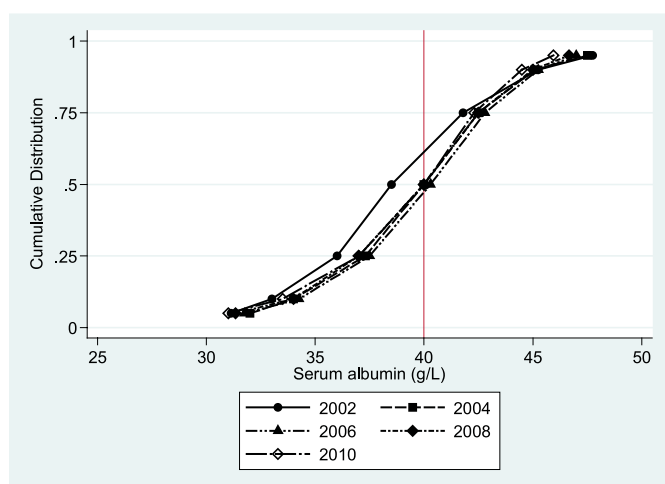
**SECTION 7.1: SERUM ALBUMIN LEVELS ON DIALYSIS**

For HD patients, mean serum albumin levels in 2010 of 38.9 g/L, and the median serum albumin levels of 39.3 g/L is still below the desired level of  $\geq 40$  g/L and has dropped compared to 2009. The percentage of patients with very low serum albumin of  $<35$ g/L has increased by 3% while patients with desirable serum albumin of  $\geq 40$ g/L has dropped by 7% compared to 2009. Nevertheless, improving trends are still indicated from the cumulative distribution graph of albumin in HD patients (Figure 7.1.1) over the 10 years.

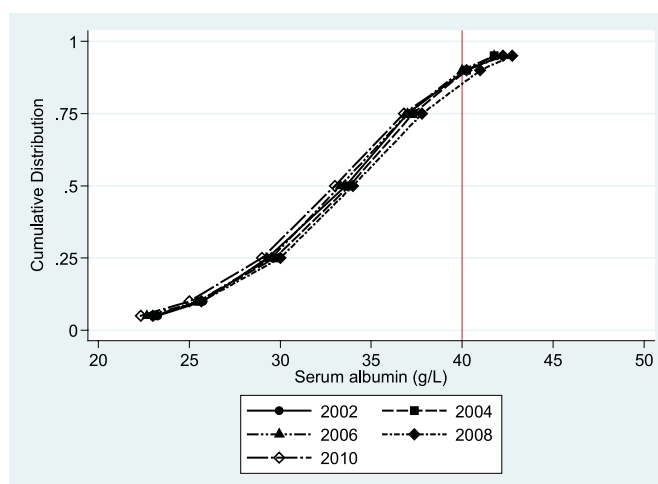
**Table 7.1.1:** Distribution of serum albumin, HD patients, 2001-2010

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients $<30$ g/L	% patients 30- $<35$ g/L	% patients 35- $<40$ g/L	% patients $\geq 40$ g/L
2001	4666	39	5.6	38.5	36	41.8	3	15	44	38
2002	5568	39.2	5.6	39	36.5	42	3	12	42	43
2003	6524	39.9	5.4	40	37.3	42.5	3	9	35	52
2004	7581	39.9	5.3	40	37	42.8	3	10	34	53
2005	8706	40	5.2	40.3	37.5	42.8	3	9	33	56
2006	10928	39.8	5.4	40.3	37.3	42.8	3	10	33	54
2007	12315	39.7	5.3	40	37	42.5	3	10	35	52
2008	14548	39.4	5.1	40	37	42.3	3	10	36	50
2009	16941	39.4	5.1	40	37	42.3	3	11	35	51
2010	18502	38.9	4.9	39.3	36.3	41.8	4	13	40	44

**Figure 7.1.1:** Cumulative distribution of Albumin, HD patients 2001-2010



**Figure 7.1.2:** Cumulative distribution of serum albumin, PD patients 2001-2010



In PD patients, the downward trend in mean serum albumin levels for patients on PD continued; from 33.3 g/L in 2001 to 32.1g/L in 2010 (Table 7.1.2). Percentage of patients with unsatisfactory serum albumin ( $<35$  g/L) increased 4% from 2009. Similarly, the percentage of patients with good serum albumin levels of  $\geq 40$ g/L dipped further from 11 % in 2009 to 8% in 2010. The cumulative distribution graph (Figure 7.1.2) showed that trends have not changed since 2001.

**Table 7.1.2:** Distribution of serum albumin, PD patients, 2001-2010

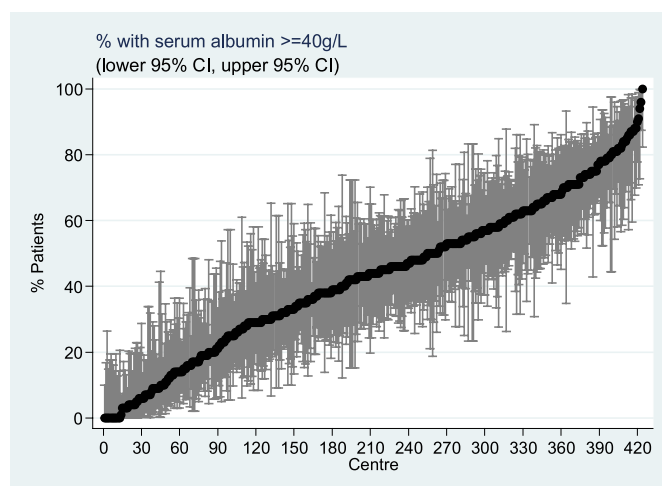
Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients $<30$ g/L	% patients 30- $<35$ g/L	% patients 35- $<40$ g/L	% patients $\geq 40$ g/L
2001	750	33.3	6.2	33.6	29.3	37	27	33	28	12
2002	862	33.9	5.9	34.3	30.8	37.5	21	35	33	12
2003	1180	33.3	5.8	33.8	29.7	37.3	26	33	30	11
2004	1284	33	6	33.8	29.5	37.3	27	32	30	11
2005	1346	33.2	6.4	33.3	29.5	37	27	33	30	10
2006	1498	33.5	6.1	33.8	30	37	25	33	30	12
2007	1753	33.6	6.2	34	30	37.8	25	31	30	14
2008	2021	33.1	6.4	33.3	29.3	37.3	28	32	27	13
2009	2138	32.7	6.4	33	29	36.8	30	34	25	11
2010	2305	32.1	6.2	32.3	28.5	36	33	35	24	8

The trend in the percent of HD centres achieving a median >50% since 2003 decreased in 2010. In fact, the number of centers which proportion of patients achieving  $\geq 40\text{g/L}$  for serum albumin have decreased to 44% in 2010 compared to 53% in 2009. Figure 7.1.3. indicated a wide variation amongst 424 HD centers reporting the proportion of patients able to achieve the target serum albumin  $\geq 40\text{g/L}$  for the year 2010, and only 1 center reported 100% of their patients achieved serum albumin of  $\geq 40\text{g/L}$ .

**Table 7.1.3:** Variation in Proportion of patients with serum albumin  $\geq 40\text{g/L}$  among HD centres 2001-2010

Year	Number of centers	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	116	0	3	15	40	58	85	100
2002	141	0	8	26	43	62	85	100
2003	175	0	18	39	55	70	92	100
2004	203	2	12	35	57	73	88	100
2005	229	4	11	42	56	69	86	100
2006	281	0	12	37	53	70	87	100
2007	313	0	13	37	54	68	86	100
2008	357	0	8	35	50	67	82	100
2009	401	0	7	36	53	65	82	100
2010	424	0	4	26.5	44	60.5	81	100

**Figure 7.1.3:** Variation in Proportion of patients with serum albumin  $\geq 40\text{g/L}$ , HD centres 2010



**Figure 7.1.4:** Variation in Proportion of patients with serum albumin  $\geq 40\text{g/L}$ , PD centres 2010

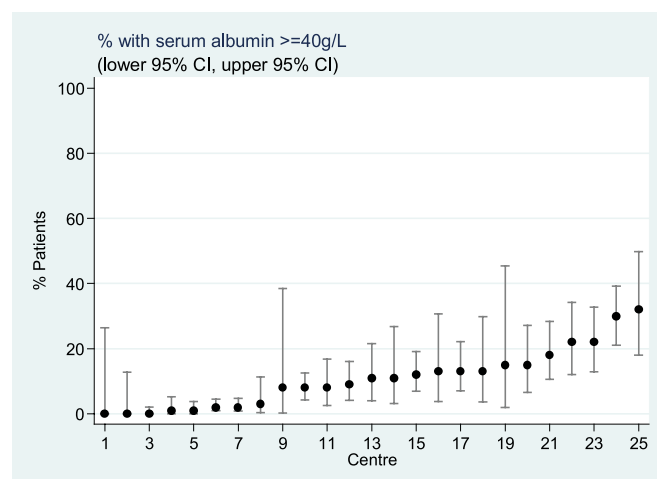


Table 7.1.4 indicates that for 25 PD centers in 2010, no center reported the maximum proportion of patients achieving the target serum albumin  $\geq 40\text{g/L}$  was 100% whilst majority of centers reported achieving less than this target. All the centers were only able to achieve less than 20% of their patients achieving the target serum albumin  $\geq 40\text{g/L}$ . (Figure 7.1.4)

**Table 7.1.4:** Variation in Proportion of patients with serum albumin  $\geq 40\text{g/L}$  among PD centres 2001-2010

Year	Number of centers	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	12	1	1	4.5	16	27.5	36	36
2002	15	5	5	6	10	24	36	36
2003	18	1	1	8	14	19	58	58
2004	18	2	2	8	14	21	35	35
2005	19	1	1	7	14	23	29	29
2006	22	1	1	6	12.5	22	42	70
2007	22	0	1	11	14	21	36	61
2008	23	0	1	4	15	25	37	52
2009	23	0	0	6	14	23	36	37
2010	25	0	0	2	11	15	30	32

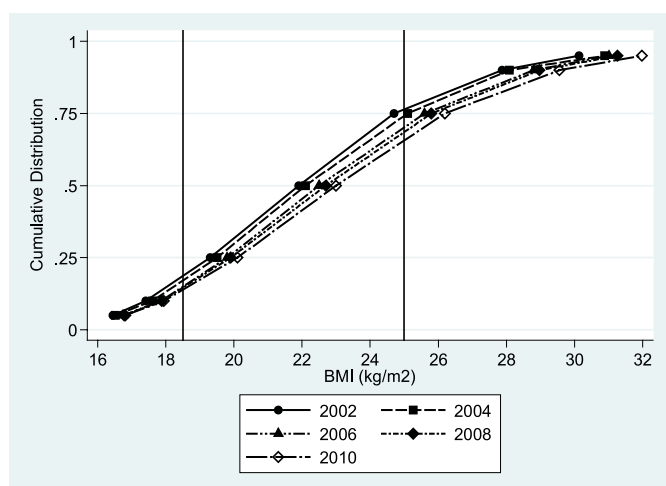
**SECTION 7.2: BODY MASS INDEX (BMI) ON DIALYSIS**

Table 7.2.1 indicates the mean BMI for HD patients from 2001 to 2010. For the year 2010 the mean BMI was 23.9 kg/m<sup>2</sup>. An increasing trend of improved BMI is observed for HD patients, with the percentage of HD patients with BMI ≥25 increased from 23% in 2001 to 35% in 2010. The percent number of patients with BMI <18.5 is at 12%. Figure 7.2.1 reflects the increasing BMI trends as the curve for 2010 continues in moving right.

**Table 7.2.1:** Distribution of BMI, HD patients, 2001-2010

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients <18.5	% patients 18.5-25	% patients ≥25
2001	4551	23	11	21.9	19.3	24.7	18	59	23
2002	5104	23.2	10.6	22	19.5	24.9	16	59	24
2003	5990	23.1	9.7	22.1	19.5	25.1	16	58	26
2004	6775	23.3	9	22.4	19.8	25.4	14	58	28
2005	7838	23.4	9	22.5	19.8	25.6	14	57	29
2006	9791	23.3	7.9	22.6	19.9	25.7	14	56	29
2007	10509	23.4	7.9	22.7	19.9	25.8	14	56	30
2008	12217	23.5	7.5	22.8	20.1	26	13	55	31
2009	13714	23.8	8.2	23	20.1	26.2	13	54	33
2010	14582	23.9	7.9	23.2	20.3	26.5	12	53	35

**Figure 7.2.1:** Cumulative distribution of BMI, HD patients 2001-2010



**Figure 7.2.2:** Cumulative distribution of BMI, PD patients 2001-2010

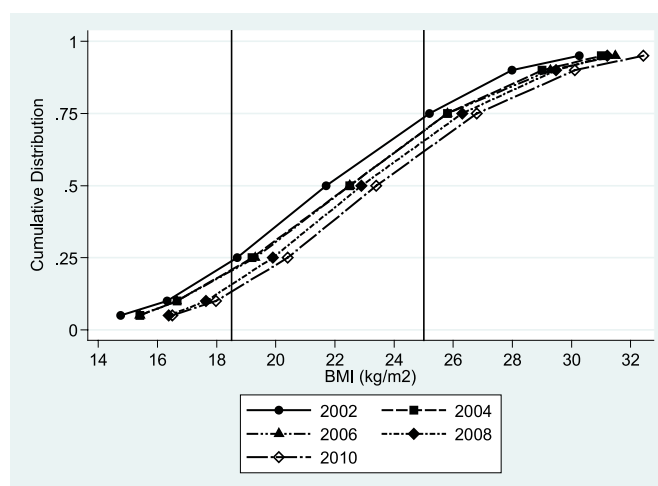


Table 7.2.2. indicates that mean BMI for PD patients from 2001 to 2010 is increasing from 22 to 24.5 despite a 3-fold increase in patient numbers. The percentage of PD patients with BMI ≥25 increased from 27% in 2001 to 39% in 2010. The shifting of the cumulative distribution curve for 2010 to the right reflects the small increases in BMI compared to the previous years. (Figure 7.2.2)

**Table 7.2.2:** Distribution of BMI, PD patients 2001-2010

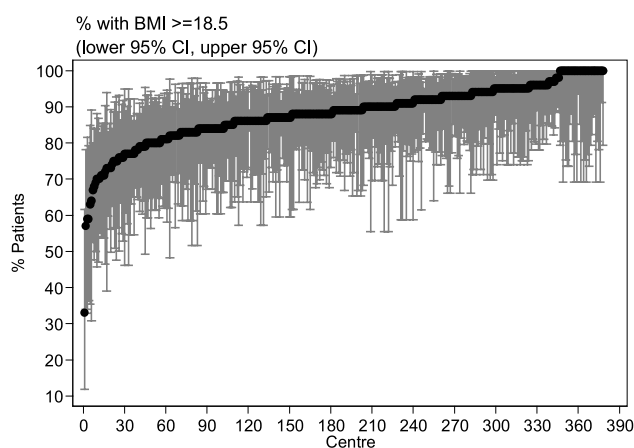
Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients <18.5	% patients 18.5-25	% patients ≥25
2001	665	22	5.1	21.7	18.7	25.2	24	50	27
2002	752	22.2	5.1	22.1	18.7	25.5	24	47	30
2003	1072	22.8	6.9	22.5	19.2	25.8	20	50	30
2004	1176	23.1	7.3	22.5	19.4	26	19	50	31
2005	1223	23	7.2	22.5	19.3	25.8	20	50	30
2006	1421	23.3	8.3	22.6	19.6	26.1	16	50	33
2007	1620	23.4	5.9	22.9	19.9	26.3	15	51	34
2008	1876	23.8	7.7	23.2	20.2	26.6	14	50	36
2009	1949	24.1	8.5	23.4	20.4	26.8	13	50	38
2010	2057	24.5	10.1	23.5	20.5	27.2	12	49	39

The variation in HD centres with proportion of patients with BMI  $\geq 18.5$  for 2010 is given in Table 7.2.3. The median for HD centers achieving the BMI target was 89% for the year 2010 and this positive trend is continuing from the previous years. A smaller variation is present amongst 378 HD centers reporting the proportion of patients able to achieve the target BMI  $\geq 18.5$  for the year 2009.

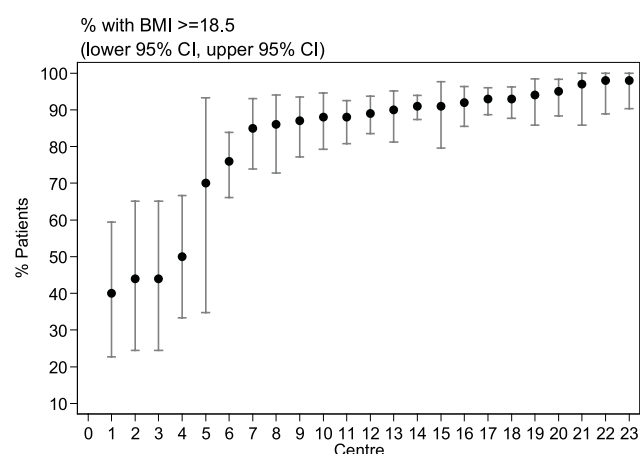
**Table 7.2.3:** Variation in Proportion of patients with BMI  $\geq 18.5$  among HD centres 2001-2010

Year	Number of centers	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	113	60	65	77	83	89	93	100
2002	133	55	67	79	85	89	100	100
2003	156	60	69	79	84	91	100	100
2004	190	58	68	81	86	92	100	100
2005	206	65	70	80	88	93	100	100
2006	262	53	70	80	86	92	100	100
2007	281	54	71	81	87	92	100	100
2008	331	59	70	82	87	93	100	100
2009	356	62	73	82	88	93	100	100
2010	378	33	73	84	89	94	100	100

**Figure 7.2.3:** Variation in Proportion of patients with BMI  $\geq 18.5$  among HD centres 2010



**Figure 7.2.4:** Variation in Proportion of patients with BMI  $\geq 18.5$  among PD centres 2010



For 23 PD centers in 2010, the maximum proportion of patients achieving the target BMI  $\geq 18.5$  was 98% whilst the worst centres reported 40% of the patients achieving this target. Figure 7.2.4 indicates that only 3 centers reported  $< 50\%$  of their patients achieving the target BMI  $\geq 18.5$  whilst 20 centers reported higher proportions ( $> 75\%$ ) meeting the target

**Table 7.2.4:** Variation in Proportion of patients with BMI  $\geq 18.5$  among PD centres 2001-2010

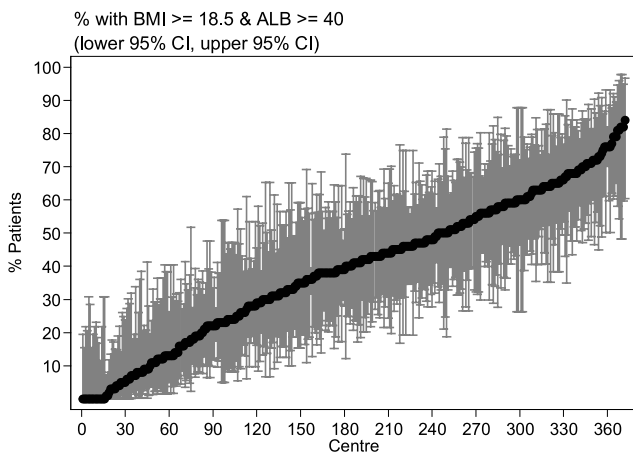
Year	Number of centers	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	11	15	15	72	77	88	92	92
2002	15	16	16	63	81	85	87	87
2003	18	18	18	74	81	88	96	96
2004	18	28	28	73	81.5	89	94	94
2005	18	17	17	70	83.5	87	91	91
2006	22	13	20	78	84	91	92	92
2007	22	15	17	76	87	92	97	100
2008	22	17	24	78	87.5	91	95	100
2009	21	29	40	80	90	93	95	97
2010	23	40	44	76	89	93	98	98

Table 7.2.5 and Figure 7.2.5 indicate a wide variation in the nutritional status of patients at 372 HD centers. Only 2% of patients in one centre met the criteria of BMI  $\geq 18.5$  and serum albumin  $>40$  g/dL in contrast to 84% of patients in the best center met the criteria. A decreasing trend in centres with severely malnourished patients is observed.

**Table 7.2.5:** Variation in Proportion of patients with BMI  $\geq 18.5$  and serum albumin  $\geq 40$  g/dL among HD centres 2001-2010

Year	Number of centers	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	106	0	0	11	31.5	50	68	100
2002	124	0	7	25.5	36.5	54	73	100
2003	150	0	17	35	47.5	61	78	100
2004	182	0	10	34	50	64	80	100
2005	195	3	11	38	50	62	80	90
2006	247	0	10	33	47	63	76	92
2007	272	0	9	32	47	60.5	74	92
2008	311	0	7	31	47	60	77	93
2009	349	0	5	33	46	61	76	92
2010	372	0	2	23	41	56.5	73	84

**Figure 7.2.5:** Variation in Proportion of patients with BMI  $\geq 18.5$  and serum albumin  $\geq 40$  g/dL among HD centres 2010



**Figure 7.2.6:** Variation in Proportion of patients with BMI  $\geq 18.5$  and serum albumin  $\geq 40$  g/dL among PD centres 2010

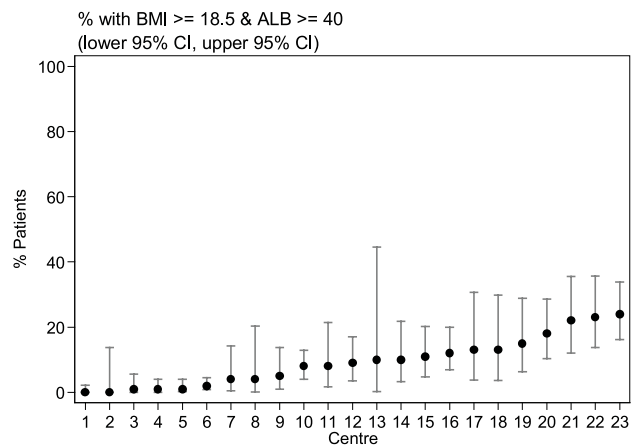


Table 7.2.6 and Figure 7.2.6 indicate a wide variation in the nutritional status of patients at 23 PD centers. Only 2% of patients in one centre met the criteria of BMI  $\geq 18.5$  and serum albumin  $\geq 40$  g/dL in contrast to 24% of patients in the best center meeting the criteria. An increasing trend in improvement of nutritional status is observed with these centres.

**Table 7.2.6:** Variation in Proportion of patients with BMI  $\geq 18.5$  and serum albumin  $\geq 40$  g/dL among PD centres 2001-2010

Year	Number of centers	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	11	1	1	5	8	20	24	24
2002	15	0	0	4	10	18	36	36
2003	18	0	0	4	10	16	46	46
2004	18	1	1	5	10.5	16	36	36
2005	18	0	0	4	8.5	17	26	26
2006	22	0	0	4	9.5	15	20	55
2007	22	0	1	4	11.5	19	36	54
2008	22	0	1	4	9	19	26	45
2009	21	0	0	5	10	19	29	35
2010	23	0	0	2	9	13	23	24

CHAPTER 8

**BLOOD PRESSURE CONTROL  
AND DYSLIPIDAEMIA  
IN PATIENTS ON DIALYSIS**

S. Prasad Menon  
Hooi Lai Seong  
Lee Wan Tin  
Sunita Bavanandan



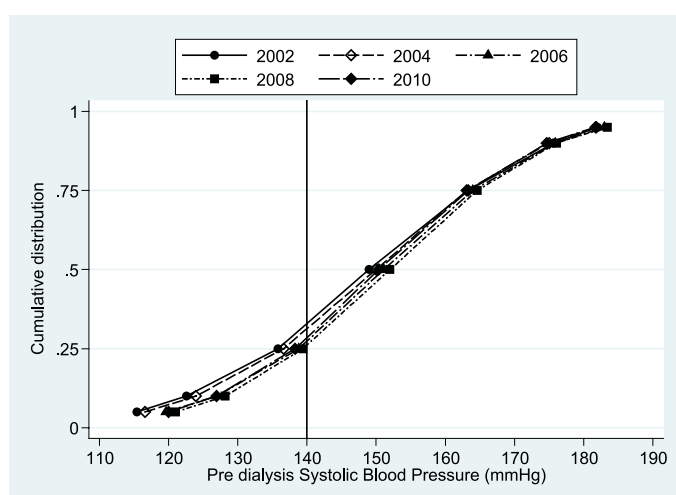
### SECTION 8.1: BLOOD PRESSURE CONTROL ON DIALYSIS

As we enter the first year of the second decade of the 21st century, the predialysis systolic blood pressure in haemodialysis patients in Malaysia remain suboptimally controlled with only 28% of haemodialysis patients achieving systolic BP < 140 mmHg in 2010 (Table 8.1.1). The mean and median predialysis systolic blood pressure in haemodialysis patients is still unacceptably high at 150.7 mmHg and 150.4 mmHg respectively in 2010.

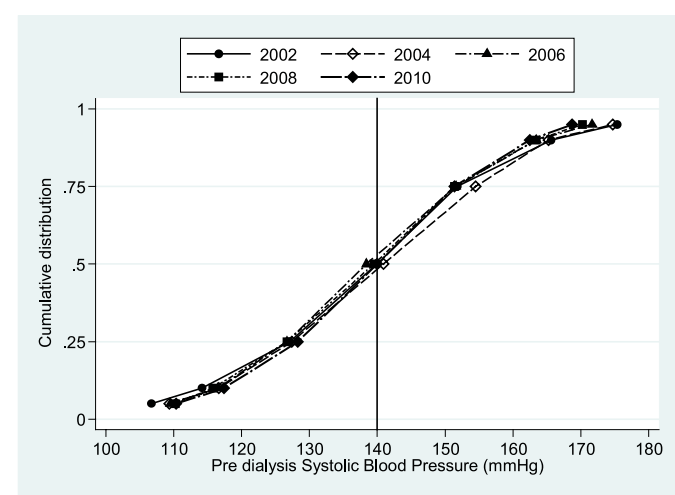
**Table 8.1.1:** Distribution of Pre dialysis Systolic Blood Pressure, HD patients 2001-2010

Year	Number of patients	Mean	SD	Median	LQ	UQ	% Patients <120 mmHg	% Patients 120-<140 mmHg	% Patients 140-<160 mmHg	% Patients 160-<180 mmHg	% Patients ≥180 mmHg
2001	5147	148.8	20.9	148.8	134.9	162.6	8	25	37	23	7
2002	5911	149.2	20.6	149	135.8	163.3	8	24	38	24	6
2003	6834	149.7	20.2	149.8	136.4	162.9	7	24	39	23	7
2004	7937	149.7	20	150	136.6	163.1	7	23	39	25	6
2005	9221	149.9	19.4	149.6	137	162.8	6	24	40	24	6
2006	11526	151.4	19.3	151.1	138.8	164	5	22	41	25	7
2007	12830	152.1	19.1	151.9	139.3	164.7	5	21	40	27	7
2008	15314	152.1	19	152	139.4	164.6	4	21	40	27	7
2009	17872	151	19	150.6	138.2	163.5	5	23	41	25	7
2010	19170	150.7	19	150.4	138.3	163.3	5	23	41	25	6

**Figure 8.1.1:** Cumulative distribution of Pre dialysis Systolic Blood Pressure, HD patients 2001-2010



**Figure 8.1.2:** Distribution of Pre dialysis Systolic Blood Pressure, PD patients 2001-2010



In contrast to haemodialysis patients, predialysis systolic blood pressure was better controlled in PD patients in 2010, with 49% of PD patients having a predialysis systolic BP < 140mmHg (Table 8.1.2). The mean and median predialysis systolic BP in CAPD patients were also lower than haemodialysis patients at 140 mmHg respectively.

**Table 8.1.2:** Distribution of Pre dialysis Systolic Blood Pressure, PD patients 2001-2010

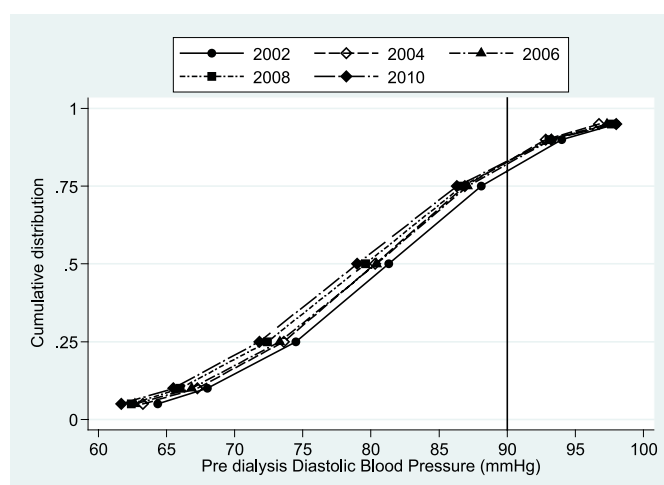
Year	Number of patients	Mean	SD	Median	LQ	UQ	% Patients <120 mmHg	% Patients 120-<140 mmHg	% Patients 140-<160 mmHg	% Patients 160-<180 mmHg	% Patients ≥180 mmHg
2001	739	139	20.2	137.5	125.8	151.7	16	38	30	13	3
2002	843	139.8	20.5	140	127.1	151.8	14	36	34	12	4
2003	1154	140.5	20.1	140	126.7	154.1	15	35	32	15	3
2004	1259	141	19.8	140.9	127.4	154.5	13	34	36	14	3
2005	1351	140.4	20.2	139.3	127.3	153.2	13	38	32	14	3
2006	1523	139.3	19.3	138.4	126.7	151.6	14	40	32	11	2
2007	1753	139.9	19.2	139.4	127	152.8	15	37	33	13	2
2008	2049	139.4	18.7	139.5	126.7	151.4	15	36	35	12	2
2009	2177	140.7	18.7	140.5	128.1	153.4	13	35	35	14	2
2010	2327	140	17.8	140	128.3	151.4	12	37	38	11	2

As in previous years, predialysis diastolic blood pressure in haemodialysis patients is better controlled than predialysis systolic blood pressure in 2010, with 85% of such patients achieving predialysis diastolic BP < 90 mmHg (Table 8.1.3). The mean and median predialysis diastolic blood pressure in haemodialysis patients is satisfactory at 79.6 mmHg and 79 mmHg respectively in 2010. Given that the diastolic BP control is better than the systolic BP control, it indicates a wide pulse pressure - an indication of poor blood vessel compliance.

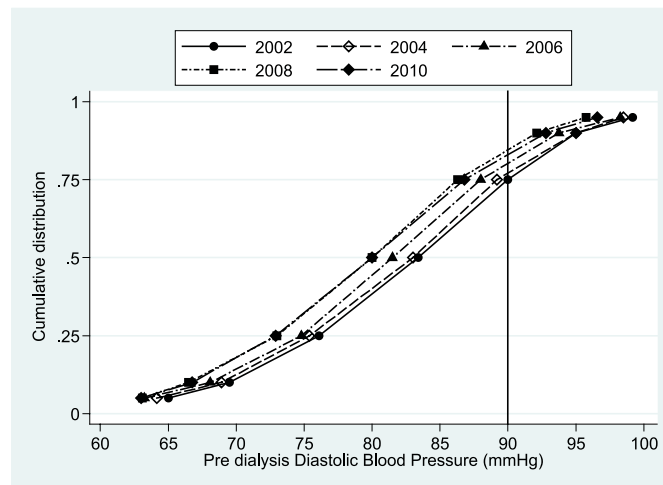
**Table 8.1.3:** Distribution of Pre dialysis Diastolic Blood Pressure, HD patients 2001-2010

Year	Number of patients	Mean	SD	Median	LQ	UQ	% Patients <70 mmHg	% Patients 70-<80 mmHg	% Patients 80-<90 mmHg	% Patients 90-<100 mmHg	% Patients ≥100 mmHg
2001	5146	81.6	10.4	81.7	75	88.3	12	30	37	17	4
2002	5907	81.2	10.4	81.3	74.5	88.1	13	30	37	16	3
2003	6832	80.6	10.2	80.8	73.9	87.2	14	32	37	14	3
2004	7935	80.3	10.2	80.3	73.6	86.9	15	33	36	14	3
2005	9221	80.3	10.6	80.4	73.5	87	15	32	36	14	3
2006	11525	80.4	11.1	80.4	73.3	87.1	16	32	35	14	3
2007	12830	80.4	11.1	80.2	73.1	87	16	32	34	14	4
2008	15312	79.8	11.1	79.6	72.4	86.7	18	33	33	13	3
2009	17871	79.7	12	79.2	72	86.4	19	33	31	12	4
2010	19168	79.6	12.1	79	71.8	86.3	20	34	31	12	4

**Figure 8.1.3:** Cumulative Distribution of Pre dialysis Diastolic Blood Pressure, HD patients 2001-2010



**Figure 8.1.4:** Cumulative Distribution of Pre dialysis Diastolic Blood Pressure, PD patients 2001-2010



The predialysis diastolic blood pressure in PD patients is similarly satisfactorily controlled in 2010 with 84% of PD patients achieving diastolic BP < 90 mmHg (Table 8.1.4). The mean and median predialysis diastolic blood pressure in PD patients were satisfactory at 79.9 mmHg and 80 mmHg respectively in 2010.

**Table 8.1.4:** Distribution of Pre dialysis Diastolic Blood Pressure, PD patients 2001-2010

Year	Number of patients	Mean	SD	Median	LQ	UQ	% Patients <70 mmHg	% Patients 70-<80 mmHg	% Patients 80-<90 mmHg	% Patients 90-<100 mmHg	% Patients ≥100 mmHg
2001	739	83.1	10.9	82.7	76.4	89.6	9	29	38	18	6
2002	843	82.8	10.8	83.4	76.1	90	11	24	41	21	5
2003	1156	82.2	10.9	82.3	75.6	89.4	12	26	38	19	4
2004	1258	82.2	10.5	83	75.4	89.2	11	28	38	18	4
2005	1351	81.6	10.9	82.2	75	88.3	12	29	40	15	5
2006	1522	81.3	10.6	81.5	74.8	88	13	28	40	15	3
2007	1752	80.6	10.7	80.7	74	86.9	14	32	38	12	3
2008	2049	79.7	10.1	80	73	86.3	16	32	36	13	2
2009	2177	80.2	10.3	80.2	73.5	86.9	15	33	35	14	3
2010	2327	79.9	10.4	80	72.9	86.8	17	33	34	13	3

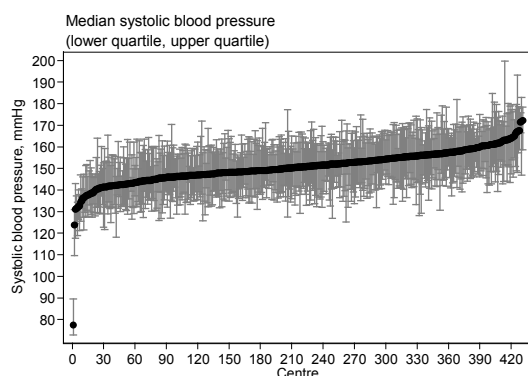
There was only a mild variation in predialysis median systolic blood pressure and predialysis median diastolic blood pressure among haemodialysis centers in 2010. This is similar to the trend of recent years (Table 8.1.5 (a) & (b)).

**Table 8.1.5:** Variation in BP control among HD centres 2001-2010

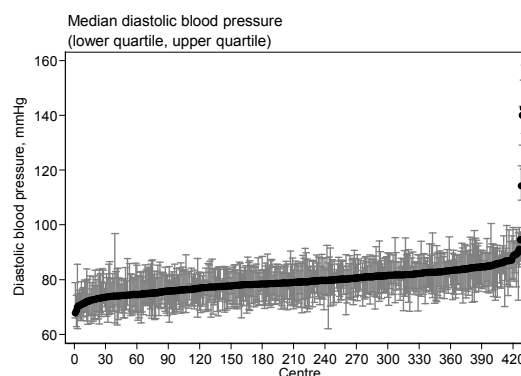
**Table 8.1.5 (a):** Median systolic blood pressure among HD patients, HD centres

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	126	126.6	136.2	143.3	149.5	154.9	161.8	180.5
2002	146	126.7	137.1	145	149.3	154	162	169.7
2003	178	126.7	136.6	144.9	150.4	156	161.4	173.7
2004	213	120	138	145.3	149.8	155.4	162.4	168.3
2005	241	128.3	136.8	143.6	150.3	155	161	171.8
2006	290	127.9	138.4	146.4	151.5	156.5	163.4	180.1
2007	318	132.1	140.1	147.5	151.9	156.6	165	175.5
2008	368	130	140.4	147.5	152.4	157	164	176.5
2009	408	121.7	139.6	146.7	151.1	155.9	162.8	173.3
2010	430	123.7	140.8	146.6	150.6	155.7	162.1	172.1

**Figure 8.1.5 (a):** Variation in median systolic blood pressure among HD patients, HD centres 2010



**Figure 8.1.5 (b):** Variation in median diastolic blood pressure among HD patients, HD centres 2010



**Table 8.1.5 (b):** Median Diastolic blood pressure among HD patients, HD centres

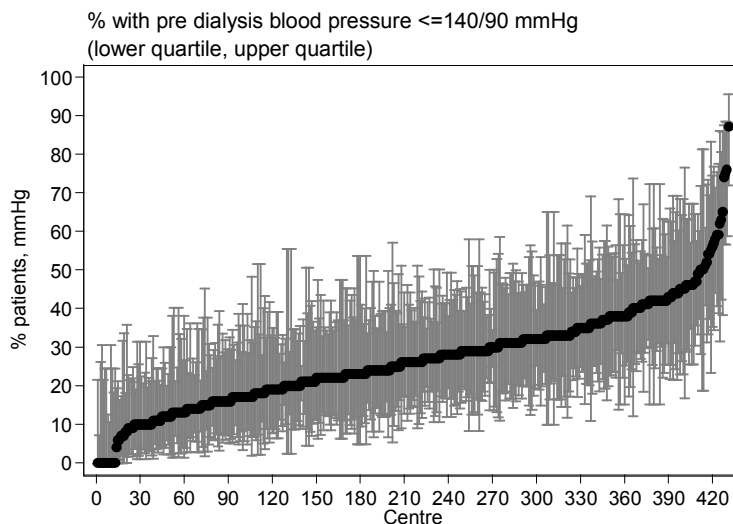
Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	126	73.9	75.7	79.8	81.9	83.7	87.4	91.3
2002	147	72.3	75.9	79.4	81.3	83.7	87.8	92
2003	178	70.1	75	78.5	80.5	83.5	86.7	93.3
2004	213	70.2	74	78.2	80.8	82.5	86.7	89.1
2005	241	67.4	73.6	78	80.4	82.8	86.7	90.3
2006	290	67.3	74.6	77.9	80.7	83.2	87.3	104.9
2007	318	70.1	73.5	77.7	80.2	83	87.3	124.5
2008	368	66.8	73.7	77.2	79.7	82.3	86.5	92.3
2009	408	68.5	73.1	76.7	79.5	82	86.2	134.4
2010	431	67.8	73	76.4	79.2	81.8	86.1	145.7

In contrast, amongst haemodialysis centres in 2010, there appears to be a wider variation in the proportion of patients achieving BP < 140/90 (Table & Figure 8.1.5(c)). There is a wide intercentile variations of 40% between the 5th to the 95th centile of patients achieving BP control of <140/90mmHg. There were even some haemodialysis centres who reported more than 70% of their patients achieving BP < 140/90 but these are “outliers” and not typical of the majority of haemodialysis centres.

**Table 8.1.5 (c):** Proportion of HD patients with pre dialysis blood pressure < 140/90 mmHg, HD centres

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	126	0	11	20	30.5	43	58	70
2002	147	0	11	21	30	40	59	71
2003	178	3	9	20	28	38	58	81
2004	213	0	9	20	29	38	56	90
2005	241	4	11	20	27	39	55	93
2006	290	0	9	17	25	35	53	74
2007	318	0	8	16	25	33	47	73
2008	368	0	8	17	24	33	48	75
2009	408	0	10	18	26	35	50	80
2010	431	0	9	18	26	34	49	87

**Figure 8.1.5 (c):** Variation in proportion of HD patients with pre dialysis blood pressure < 140/90 mmHg, HD centers 2010



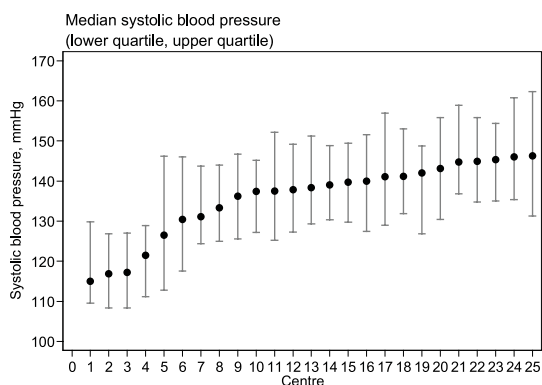
There is some variation in predialysis median systolic blood pressure and predialysis median diastolic blood pressure among PD centers in 2010 (Figure 8.1.6 (a) & (b)).

**Table 8.1.6:** Variation in BP control among PD centres 2001-2010

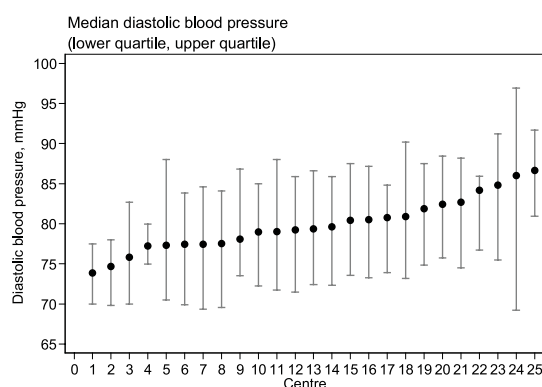
**Table 8.1.6 (a):** Median systolic blood pressure among PD patients

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	11	119.6	119.6	130.7	137.5	138.8	149	149
2002	15	123.6	123.6	134.5	140	144.5	148.2	148.2
2003	18	123.8	123.8	132.4	142.4	144.3	151.8	151.8
2004	18	122.9	122.9	134.5	139.8	143.8	149.7	149.7
2005	19	122.6	122.6	134.8	136.6	142	158	158
2006	22	113	118.3	130.2	136.3	140.4	146	154.9
2007	22	114.6	115.8	135.2	138.2	141.8	147.4	153.5
2008	22	111.5	118.3	136	138.4	141.9	147.7	147.9
2009	23	113.7	115.6	133.6	138.5	145	150.9	161.5
2010	25	115	116.9	131.1	138.4	142	146	146.3

**Figure 8.1.6 (a):** Variation in median systolic blood pressure among PD patients, PD centres 2010



**Figure 8.1.6 (b):** Variation in median diastolic blood pressure among PD patients, PD centres 2010



**Table 8.1.6 (b):** Median Diastolic blood pressure among PD patients, PD centres

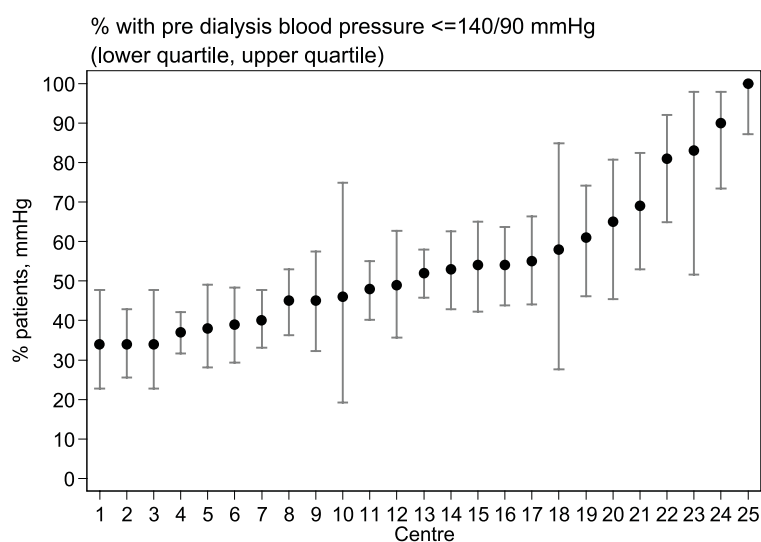
Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	11	78	78	80.9	83.4	84.8	88	88
2002	15	75.7	75.7	81.8	83.3	85.7	89.5	89.5
2003	18	77.5	77.5	81.2	82.9	84	88	88
2004	18	77.5	77.5	80.8	83.4	84.1	87	87
2005	19	74.4	74.4	80.3	82.8	84.2	86	86
2006	22	71.6	74	78.9	81.4	82.4	86.5	88.4
2007	22	68	77.3	78.9	80	82.3	83.2	87
2008	22	75.3	76.2	78.1	79.8	82	84.5	86.8
2009	23	73.3	73.5	78.5	79.3	82	84.3	87.9
2010	25	73.9	74.7	77.5	79.4	81.9	86	86.7

Similar to haemodialysis centres, there was also a wide variation amongst PD centres in the proportion of patients achieving BP < 140/90 (Table & Figure 8.1.6 (c)). ie 56% difference between the 5th and 95% centile. Overall BP control is better in PD patients.

**Table 8.1.6 (c):** Proportion of PD patients with pre dialysis blood pressure < 140/90 mmHg, PD centres

Year	Number of centre	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	11	36	36	48	52	63	87	87
2002	15	19	19	33	47	56	90	90
2003	18	28	28	38	46.5	65	74	74
2004	18	30	30	38	47	56	73	73
2005	19	23	23	43	55	62	92	92
2006	22	18	37	43	58.5	70	100	100
2007	22	27	29	45	53.5	68	91	91
2008	22	28	29	42	54	58	87	96
2009	23	10	29	40	51	58	92	96
2010	25	34	34	40	52	61	90	100

**Figure 8.1.6 (c):** Variation in proportion of PD patients with pre dialysis blood pressure ≤140/90 mmHg, PD centres 2010



In summary, the BP control is better in PD patients as compared to HD patients with 52% achieving BP control of <140/90mmHg as compared to 26% in HD patients. This warrants further attention to control of salt and water intake and achievement of optimum dry weight.

### SECTION 8.2: DYSLIPIDEMIA IN DIALYSIS PATIENTS

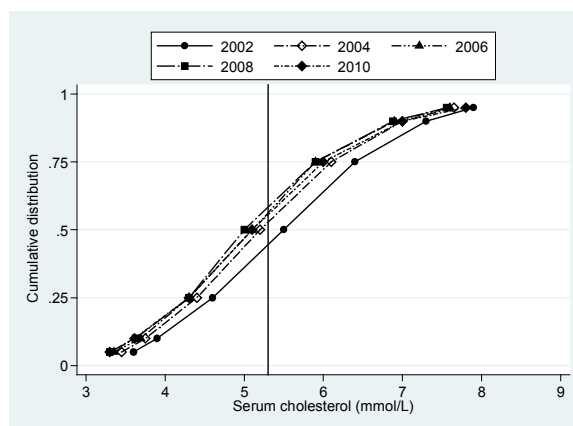
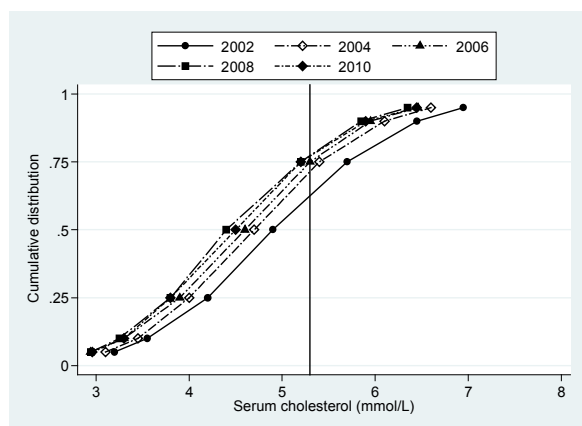
The trend over the past 10 years of improving total cholesterol levels in HD patients continued in 2010, with 77% of HD patients achieving total cholesterol < 5.3 mmol/L (Table & Figure 8.2.1) compared to 60% in 2001. The mean and median serum cholesterol levels in HD patients were 4.6 mmol/L and 4.5mmol/L respectively.

**Table 8.2.1:** Distribution of serum Cholesterol, HD patients 2001-2010

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients <3.5 mmol/L	% patients 3.5-<5.3 mmol/L	% patients 5.3-<6.2 mmol/L	% patients ≥6.2 Mmol/L
2001	3898	5.1	1.3	4.9	4.2	5.8	8	52	24	16
2002	4751	5	1.2	4.9	4.2	5.7	9	55	24	13
2003	5806	4.8	1.1	4.8	4.1	5.5	9	59	21	11
2004	6710	4.7	1.1	4.7	4	5.4	11	60	21	8
2005	7906	4.7	1.1	4.6	4	5.3	12	61	19	8
2006	10139	4.6	1.1	4.6	3.9	5.3	14	62	17	7
2007	11347	4.6	1.1	4.5	3.8	5.2	14	63	17	6
2008	13820	4.5	1.1	4.4	3.8	5.2	15	63	16	6
2009	15905	4.6	1.1	4.5	3.8	5.2	14	63	16	6
2010	17424	4.6	1.1	4.5	3.8	5.2	14	63	16	7

**Figure 8.2.1:** Cumulative distribution of Cholesterol, HD patients 2001-2010

**Figure 8.2.2:** Cumulative distribution of Cholesterol (mmol/L), PD patients 2001-2010



However total cholesterol levels in PD patients was less optimally controlled in comparison with HD patients, with 56% of PD patients achieving total cholesterol < 5.3 mmol/L in 2010 (Table & Figure 8.2.2). The mean and median serum cholesterol levels in PD patients in 2010 were 5.2 mmol/L and 5.1 mmol/L respectively.

**Table 8.2.2:** Distribution of serum Cholesterol, PD patients 2001-2010

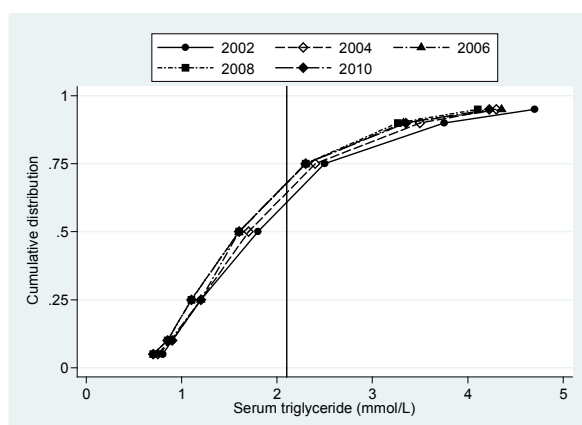
Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients <3.5 mmol/L	% patients 3.5-<5.3 mmol/L	% patients 5.3-<6.2 mmol/L	% patients ≥6.2 Mmol/L
2001	581	5.8	1.4	5.7	4.8	6.6	2	36	27	35
2002	766	5.6	1.4	5.5	4.6	6.4	4	38	28	29
2003	1104	5.4	1.4	5.3	4.4	6.1	5	45	27	23
2004	1230	5.3	1.4	5.2	4.4	6.1	5	48	26	21
2005	1242	5.2	1.3	5	4.3	5.9	5	55	22	18
2006	1395	5.2	1.4	5.1	4.3	5.9	6	51	25	18
2007	1629	5.1	1.3	5.1	4.2	5.9	8	50	24	18
2008	1902	5.2	1.4	5	4.3	5.9	7	51	23	18
2009	2016	5.3	1.5	5.1	4.3	6	6	50	24	20
2010	2186	5.2	1.4	5.1	4.3	6	7	49	24	20

Serum triglyceride control was slightly better in HD patients than PD patients in 2010, with 75% of HD patients achieving serum triglyceride levels < 2.3 mmol/L (Table & Figure 8.2.3) compared with 70% of CAPD patients achieving serum triglyceride level < 2.3 mmol/L (Table & Figure 8.2.4). Control of triglyceride levels in HD patients has been steadily improving over the past 10 years.

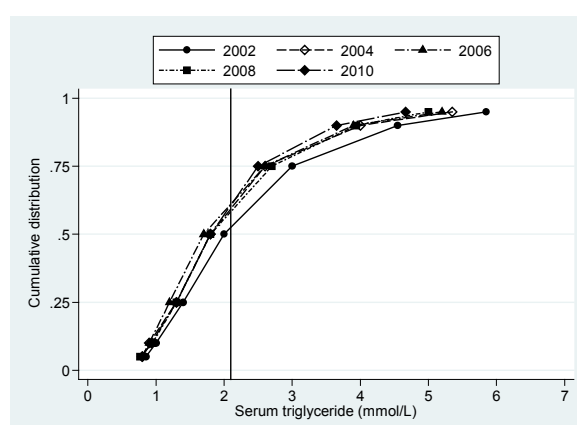
**Table 8.2.3:** Distribution of serum Triglyceride, HD patients 2001-2010

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients <1.7 mmol/L	% patients 1.7-<2.3 mmol/L	% patients 2.3-<3.5 mmol/L	% patients ≥3.5 mmol/L
2001	3162	2.1	1.4	1.7	1.2	2.5	48	22	17	13
2002	3861	2.1	1.4	1.8	1.2	2.5	47	22	18	12
2003	4710	2	1.3	1.7	1.2	2.5	48	23	18	11
2004	5607	2	1.2	1.7	1.2	2.4	51	23	17	10
2005	6950	2	1.3	1.7	1.2	2.4	50	22	18	10
2006	9522	2	1.3	1.6	1.2	2.3	54	21	16	9
2007	10882	1.9	1.2	1.6	1.1	2.3	55	21	16	8
2008	12927	1.9	1.2	1.6	1.1	2.3	56	20	15	8
2009	15184	1.9	1.3	1.6	1.1	2.3	54	21	16	9
2010	16737	1.9	1.3	1.6	1.1	2.3	54	21	16	9

**Figure 8.2.3:** Cumulative distribution of serum triglyceride, HD patients 2001-2010



**Figure 8.2.4:** Cumulative distribution of serum triglyceride, PD patients 2001-2010



**Table 8.2.4:** Distribution of serum Triglyceride, PD patients 2001-2010

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients <1.7 mmol/L	% patients 1.7-<2.3 mmol/L	% patients 2.3-<3.5 mmol/L	% patients ≥3.5 mmol/L
2001	576	2.6	1.8	2	1.4	3	36	22	22	20
2002	767	2.5	1.7	2	1.4	3	39	21	22	18
2003	1100	2.3	1.6	1.8	1.2	2.8	45	20	21	14
2004	1223	2.2	1.6	1.8	1.3	2.6	47	23	17	13
2005	1241	2.2	1.5	1.8	1.3	2.7	43	24	18	14
2006	1391	2.2	1.6	1.7	1.2	2.6	47	21	18	13
2007	1625	2.1	1.4	1.8	1.3	2.6	45	24	19	12
2008	1907	2.2	1.5	1.8	1.3	2.7	45	21	20	14
2009	2017	2.2	1.6	1.8	1.3	2.7	46	21	20	14
2010	2177	2.1	1.4	1.8	1.3	2.5	47	23	18	11



There was a mild variation in median serum cholesterol levels and proportion of HD patients with serum cholesterol < 5.3 mmol/L in HD centers in 2010 (Table 8.2.5 (a) & (b)). Compared to 10 years ago, the median of the proportion of patients with serum cholesterol level < 5.3 mmol/L in HD centers has significantly increased (60% in 2001 to 78% in 2010 (Table 8.2.5(b)).

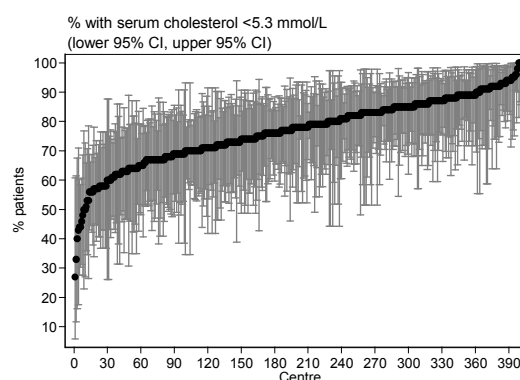
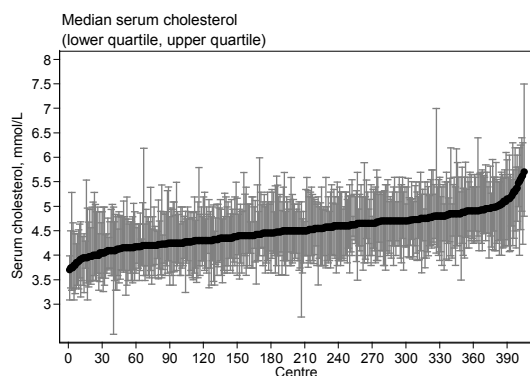
**Table 8.2.5:** Variation in dyslipidaemia among HD centres 2001-2010

**Table 8.2.5 (a):** Median serum cholesterol level among HD patients

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	96	4.1	4.4	4.7	5	5.2	5.6	6.3
2002	122	4.3	4.5	4.7	4.9	5.1	5.5	6.4
2003	153	4.2	4.3	4.6	4.8	5	5.3	5.6
2004	182	3.9	4.2	4.5	4.7	4.9	5.3	6.1
2005	214	3.8	4.1	4.4	4.6	4.8	5.2	5.7
2006	267	3.4	3.9	4.3	4.6	4.8	5.1	5.9
2007	286	3.6	4	4.3	4.5	4.8	5.1	5.4
2008	341	3.4	3.9	4.3	4.5	4.7	5.1	6.3
2009	377	3.5	4	4.3	4.5	4.7	5.1	5.6
2010	405	3.7	4	4.3	4.5	4.7	5.1	5.7

**Figure 8.2.5 (a):** Variation in median serum cholesterol level among HD patients, HD centres 2010

**Figure 8.2.5 (b):** Variation in proportion of patients with serum cholesterol < 5.3 mmol/L, HD centres 2010



**Table 8.2.5 (b):** Proportion of HD patients with serum cholesterol < 5.3 mmol/L

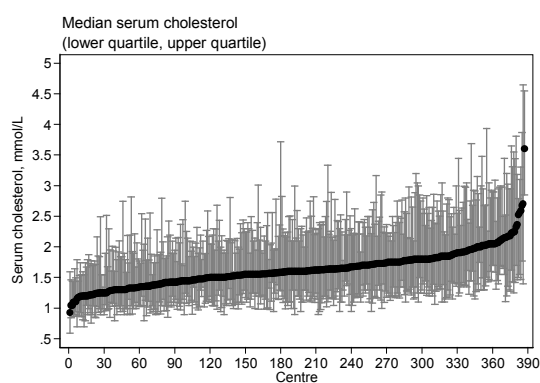
Year	Number of centre	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	96	14	36	54	60	69	80	89
2002	122	28	44	58	64	71	78	93
2003	153	40	47	60	68	76	83	92
2004	182	38	48	61	70	79	90	94
2005	214	38	52	66	74	81	91	100
2006	267	23	56	69	76	83	92	100
2007	286	38	59	69	77	84	93	100
2008	341	30	58	70	79	86	93	100
2009	377	36	58	70	78	85	93	100
2010	405	27	57	70	78	85	93	100

The proportion of patients with triglyceride level < 2.1 mmol/L in HD centres has only mildly increased from 66% in 2001 to 71% in 2010 (Table 8.2.5(d)).

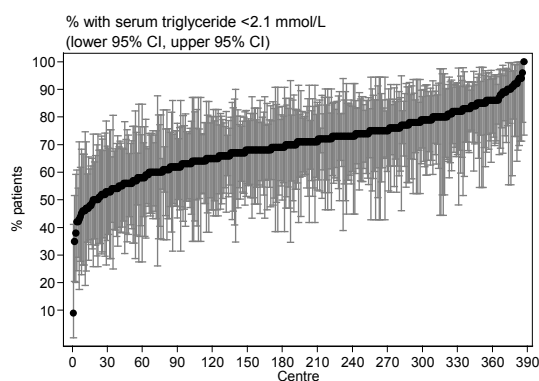
**Table 8.2.5 (c):** Median serum triglyceride level among HD patients

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	83	1.1	1.4	1.5	1.7	2	2.3	3.1
2002	98	1.1	1.4	1.6	1.8	2	2.3	3.2
2003	130	1.2	1.3	1.5	1.7	1.9	2.2	2.5
2004	157	1	1.3	1.5	1.7	1.8	2.2	3
2005	194	0.9	1.3	1.5	1.7	1.9	2.2	2.6
2006	254	0.9	1.3	1.5	1.6	1.8	2.2	4
2007	274	0.8	1.2	1.4	1.6	1.8	2.1	2.9
2008	317	1	1.2	1.4	1.6	1.7	2	2.3
2009	353	1	1.2	1.4	1.6	1.8	2.1	2.4
2010	387	0.9	1.2	1.5	1.6	1.8	2.1	3.6

**Figure 8.2.5 (c):** Variation in median serum triglyceride level among HD patients, HD centers 2010



**Figure 8.2.5 (d):** Variation in proportion of patients with serum triglyceride < 2.1 mmol/L, HD centers 2010



**Table 8.2.5 (d):** Proportion of HD patients with serum triglyceride < 2.1 mmol/L

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	83	29	45	57	66	76	86	90
2002	98	27	44	55	65.5	72	81	93
2003	130	27	44	58	67.5	75	90	100
2004	157	20	47	60	68	79	87	96
2005	194	29	44	59	67	74	84	100
2006	254	7	46	63	70	76	88	100
2007	274	36	50	63	70	78	88	95
2008	317	36	54	64	71	79	87	100
2009	353	38	50	63	70	77	88	100
2010	387	9	50	63	71	78	88	100

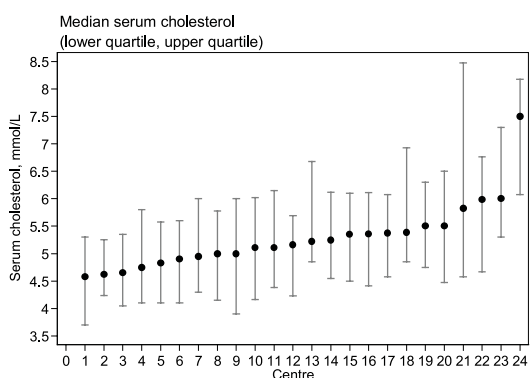
There was a mild variation in median cholesterol levels among PD patients in 2010 (Table & Figure 8.2.6 (a)). The median of the proportion of PD patients with serum cholesterol < 5.3 mmol/L has gradually increased from 34.5% in 2001 to 53.3% in 2010, reflecting better control of serum cholesterol levels in PD patients in recent years (Table & Figure 8.2.6 (b)).

**Table 8.2.6:** Variation in dyslipidaemia among PD centres 2001-2010

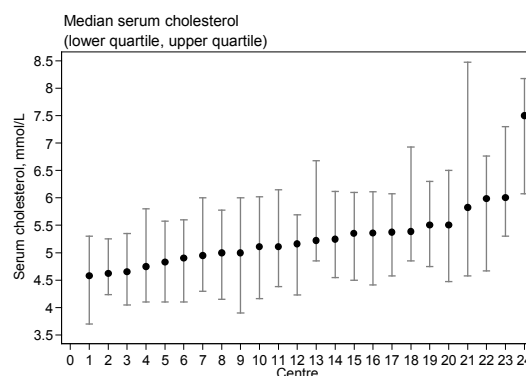
**Table 8.2.6 (a):** Median serum cholesterol level among PD patients

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	10	5	5	5.6	5.9	6.1	6.2	6.2
2002	15	4.9	4.9	5.4	5.5	5.7	6.2	6.2
2003	18	4.5	4.5	5	5.3	5.7	5.9	5.9
2004	18	4.6	4.6	4.9	5.3	5.5	6.1	6.1
2005	19	4.4	4.4	4.7	5	5.4	5.9	5.9
2006	21	4.4	4.6	4.9	5	5.3	6.1	6.2
2007	22	4.5	4.5	4.8	5.2	5.4	6.1	6.3
2008	21	4.3	4.5	4.8	5.1	5.4	5.5	5.8
2009	21	4.6	4.7	4.8	5.1	5.4	5.8	6.8
2010	24	4.6	4.6	4.9	5.2	5.4	6	7.5

**Figure 8.2.6 (a):** Variation in median serum cholesterol level among PD patients, PD centres 2010



**Figure 8.2.6 (b):** Variation in proportion of patients with serum cholesterol < 5.3 mmol/L, PD centres 2010



**Table 8.2.6 (b):** Proportion of PD patients with serum cholesterol < 5.3 mmol/L

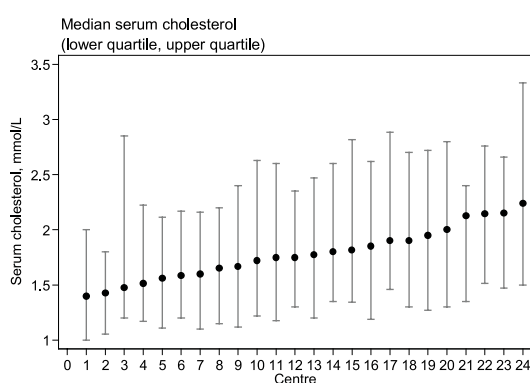
Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	10	22	22	30	34.5	45	63	63
2002	15	13	13	33	42	45	80	80
2003	18	22	22	39	48.5	59	83	83
2004	18	24	24	42	51	60	71	71
2005	19	29	29	47	60	70	77	77
2006	21	20	25	48	59	66	75	79
2007	22	29	30	47	52.5	68	77	86
2008	21	42	42	47	56	69	75	77
2009	21	17	37	48	54	62	74	77
2010	24	8	22	45	53.5	62	73	77

As in previous years, there was only mild variation among PD centres with the median triglyceride levels in PD patients as well as proportion of patients with serum triglyceride levels < 2.1 mmol/L (Table 8.2.6.(c) & (d)). The median of the proportion of PD patients with serum triglyceride < 2.1 mmol/L has gradually increased from 53% in 2001 to 62% in 2010.

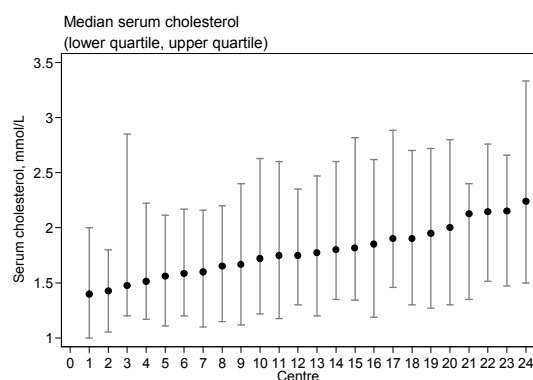
**Table 8.2.6 (c):** Median serum triglyceride level among PD patients

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	10	1.5	1.5	1.9	2	2.1	3	3
2002	15	1.5	1.5	1.8	1.9	2	2.4	2.4
2003	18	1.2	1.2	1.7	1.8	1.9	2.3	2.3
2004	18	1.3	1.3	1.7	1.8	1.8	2.2	2.2
2005	19	1.4	1.4	1.6	1.9	2	2.2	2.2
2006	21	1.1	1.4	1.6	1.8	1.9	2	2.6
2007	22	1.2	1.5	1.7	1.8	1.9	2.1	2.7
2008	23	1.3	1.5	1.7	1.8	2	2.1	2.2
2009	22	1.3	1.5	1.7	1.7	1.9	2.1	2.6
2010	24	1.4	1.4	1.6	1.8	1.9	2.2	2.2

**Figure 8.2.6 (c):** Variation in median serum triglyceride level among PD patients, PD centres 2010



**Figure 8.2.6 (d):** Variation in proportion of patients with serum triglyceride < 2.1 mmol/L, PD centres 2010



**Table 8.2.6 (d):** Proportion of PD patients with serum triglyceride < 2.1 mmol/L

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	10	27	27	50	53	58	68	68
2002	15	38	38	52	56	58	76	76
2003	18	49	49	55	58.5	62	92	92
2004	18	47	47	60	62	65	88	88
2005	19	40	40	54	60	69	91	91
2006	21	33	52	56	61	64	78	82
2007	22	40	52	58	65	69	80	81
2008	23	48	52	56	61	65	82	84
2009	22	25	50	57	59.5	68	71	72
2010	24	47	48	58.5	62	68.5	77	83

In summary, it can be said that lipid levels are better controlled in HD patients as compared to PD patients in 2010, but the overall picture has improved over the last decade.



CHAPTER 9

**CHRONIC KIDNEY DISEASE-  
MINERAL AND BONE DISORDERS**

Rozina Ghazalli  
Fan Kin Sing  
Ching Chen Hua  
Ghazali B Ahmad  
Liew Yew Fong

## SECTION 9.1: TREATMENT OF RENAL BONE DISEASE

Calcium carbonate remained the main phosphate binder for both HD patients (91%) and PD patients (88%) over the last decade. The percentage of patients on aluminium based phosphate binder has decreased steadily to a minimal number for both HD and PD patients from 2.8% and 0.6% in 2001 to 0.14% and 0.10% in 2010 respectively. On the other hand, the use of lanthanum as phosphate binder has increased very slowly from 0.13% and 0.18% in 2006 to 1.92% and 2.42% in 2010 for both HD and PD patients since its introduction into Malaysia in 2006. There was a slightly higher percentage of PD patients taking lanthanum compared to HD patients. Calcitriol remained the main Vitamin D used in treatment of renal bone disease for both HD and PD patients. The percentage of patients on calcitriol therapy has increased in both HD and PD patients since 2001. The use of Paricalcitol has also increased slowly among HD patients from 0.29% in 2006 to 0.79% in 2010 but its usage has reduced in PD patients from 0.21% in 2006 to 0.10% in 2010. The number of patients underwent parathyroidectomy has shown a downward trend since 2006 in both HD and PD patients from 1.3% and 0.97% in 2006 to 0.87% and 0.29% in 2010 respectively. More HD patients underwent parathyroidectomy compared to PD patients. (Tables 9.1.1 and 9.1.2)

**Table 9.1.1** Treatment for renal bone disease, HD patients, 2001-2010

Year	Number of patients	Number of patients On CaCO <sub>3</sub>	% on CaCO <sub>3</sub>	Number on patients on Al(OH) <sub>3</sub>	Number of patients on Lanthanum	Number of patients on calcitriol	% on calcitriol	Number of patients on Paricalcitol	Number of patients had Parathyroidectomy
2001	5194	4810	93	145	0	1145	22	0	0
2002	6108	5536	91	171	0	1375	23	0	0
2003	7018	6425	92	118	0	1690	24	0	0
2004	8164	7408	91	106	0	2029	25	0	0
2005	9351	8568	92	98	0	2556	27	0	43
2006	11682	10776	92	71	15	3817	33	34	152
2007	12907	11868	92	57	37	4927	38	58	181
2008	15399	14141	92	72	86	5897	38	43	174
2009	17969	16446	92	32	247	7340	41	80	167
2010	19300	17604	91	27	372	8502	44	153	169

**Table 9.1.2** Treatment for renal bone disease, PD patients, 2001-2010

Year	Number of patients	Number of patients On CaCO <sub>3</sub>	% on CaCO <sub>3</sub>	Number on patients on Al(OH) <sub>3</sub>	Number of patients on Lanthanum	Number of patients on calcitriol	% on calcitriol	Number of patients on Paricalcitol	Number of patients had Parathyroidectomy
2001	781	588	75	5	0	84	11	0	0
2002	891	713	80	6	0	130	15	0	0
2003	1543	1306	85	15	0	311	20	0	0
2004	1842	1552	84	24	0	439	24	0	0
2005	2207	1862	84	21	0	534	24	0	8
2006	2787	2373	85	14	5	658	24	6	27
2007	3577	3142	88	8	22	1019	28	9	22
2008	4044	3495	86	14	42	1148	28	6	26
2009	3482	2945	85	12	78	1129	32	5	16
2010	3844	3391	88	4	93	1467	38	4	11

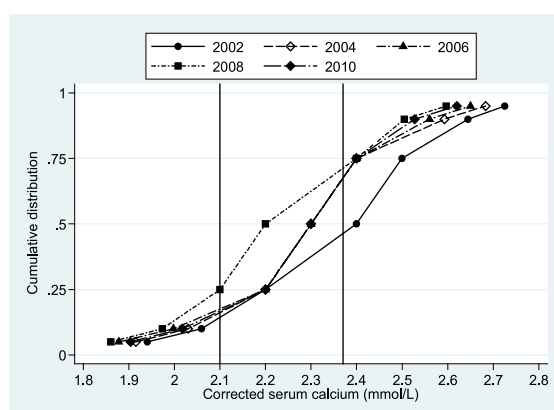
## SECTION 9.2: SERUM CALCIUM AND PHOSPHATE CONTROL

The median corrected serum calcium level has remained stable for the last decade for both HD and PD patients. However, more HD patients achieved normal range serum calcium level (2.1 to 2.37 mmol/l) compared to PD patients (52% vs 37%) in 2010. (Tables and Figures 9.2.1 and 9.2.2)

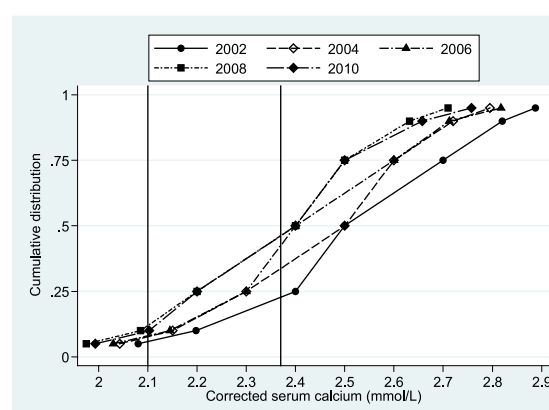
**Table 9.2.1:** Distribution of corrected serum calcium, HD patients, 2001-2010

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients $\geq 2.1$ & $\leq 2.37$ mmol/L
2001	4618	2.4	0.2	2.4	2.2	2.5	40
2002	5485	2.3	0.3	2.3	2.2	2.5	43
2003	6466	2.3	0.2	2.3	2.2	2.4	46
2004	7536	2.3	0.2	2.3	2.2	2.4	47
2005	8630	2.3	0.2	2.3	2.2	2.4	49
2006	10881	2.3	0.2	2.3	2.1	2.4	50
2007	12275	2.2	0.2	2.2	2.1	2.4	52
2008	14478	2.3	0.2	2.3	2.1	2.4	53
2009	16851	2.3	0.2	2.3	2.2	2.4	52
2010	18400	2.3	0.2	2.3	2.2	2.4	52

**Figure 9.2.1** Cumulative distribution of corrected serum calcium, HD patients, 2001-2010



**Figure 9.2.2:** Cumulative distribution of corrected serum calcium, PD patients, 2001-2010



**Table 9.2.2:** Distribution of corrected serum calcium, PD patients, 2001-2010

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients $\geq 2.1$ & $\leq 2.37$ mmol/L
2001	744	2.5	0.3	2.5	2.4	2.7	22
2002	859	2.5	0.2	2.5	2.3	2.6	24
2003	1167	2.4	0.2	2.5	2.3	2.6	27
2004	1276	2.5	0.2	2.5	2.3	2.6	23
2005	1338	2.4	0.2	2.4	2.3	2.6	30
2006	1495	2.4	0.2	2.4	2.3	2.5	38
2007	1748	2.4	0.2	2.4	2.2	2.5	42
2008	2017	2.4	0.2	2.4	2.3	2.5	38
2009	2135	2.4	0.2	2.4	2.2	2.5	39
2010	2301	2.4	0.2	2.4	2.3	2.5	37

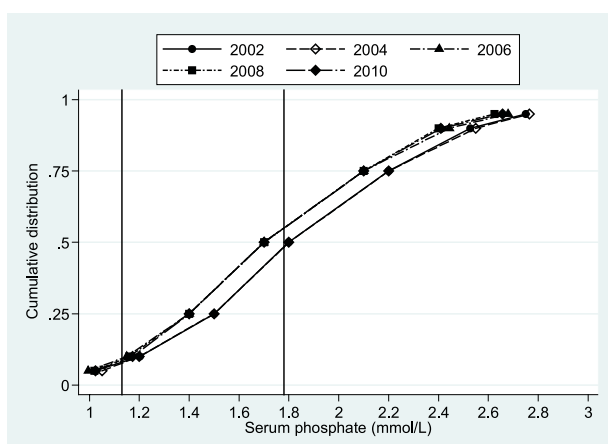


However, PD patients had better phosphate control compared to HD patients (median level 1.5 vs 1.7mmol/l) and larger percentage of PD patients had normal range phosphate level (1.13-1.78mmol/l) as opposed to HD patients (53 vs 46%). (Tables and Figures 9.2.3 and 9.2.4)

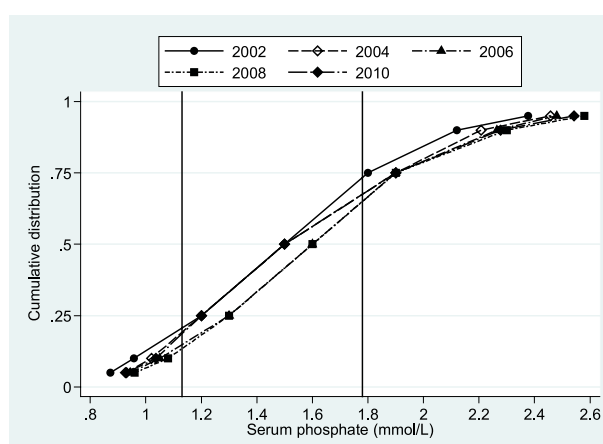
**Table 9.2.3:** Distribution of serum phosphate, HD patients, 2001-2010

Year	Number of patients	mean	SD	Median	LQ	UQ	%patients <1.13 mmol/L	%patients ≥1.13&<1.78 mmol/L	%patients ≥1.78&<2.6 mmol/L	%patients >2.6 mmol/L
2001	4765	1.9	0.5	1.8	1.5	2.2	7	40	45	8
2002	5679	1.9	0.5	1.8	1.5	2.2	7	38	45	10
2003	6588	1.8	0.5	1.8	1.5	2.2	7	41	43	9
2004	7620	1.8	0.5	1.8	1.5	2.2	8	42	42	7
2005	8834	1.8	0.5	1.7	1.4	2.1	9	45	40	6
2006	11129	1.8	0.5	1.7	1.4	2.1	9	46	39	6
2007	12424	1.8	0.5	1.7	1.4	2.1	9	47	39	5
2008	14874	1.7	0.5	1.7	1.4	2	9	48	37	5
2009	17247	1.8	0.5	1.7	1.4	2.1	8	46	39	6
2010	18637	1.8	0.5	1.7	1.4	2.1	8	46	41	6

**Figure 9.2.3:** Cumulative distribution of serum phosphate, HD patients, 2001-2010



**Figure 9.2.4:** Cumulative distribution of serum phosphate, PD patients, 2001-2010



**Table 9.2.4:** Distribution of serum phosphate, PD patients, 2001-2010

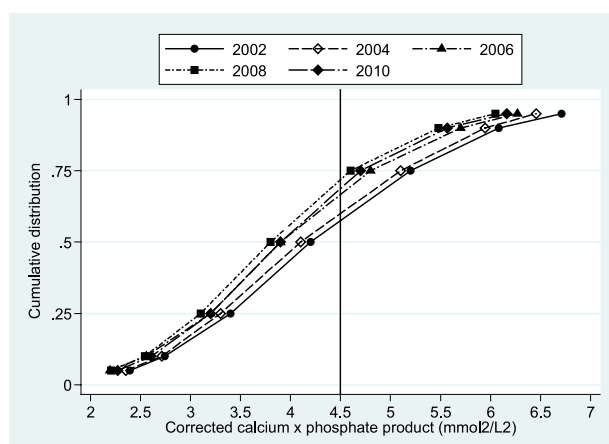
Year	Number of patients	mean	SD	Median	LQ	UQ	%patients <1.13 mmol/L	%patients ≥1.13&<1.78 mmol/L	%patients ≥1.78&<2.6 mmol/L	%patients >2.6 mmol/L
2001	732	1.5	0.5	1.5	1.2	1.8	21	53	24	2
2002	862	1.5	0.5	1.5	1.2	1.8	21	52	25	2
2003	1173	1.6	0.5	1.5	1.2	1.9	16	53	28	3
2004	1278	1.6	0.5	1.6	1.3	1.9	15	52	29	3
2005	1343	1.6	0.5	1.6	1.3	1.9	15	52	29	3
2006	1511	1.6	0.5	1.6	1.3	1.9	13	54	29	4
2007	1757	1.6	0.5	1.6	1.3	1.9	13	55	27	5
2008	2022	1.6	0.5	1.5	1.3	1.9	15	55	25	4
2009	2147	1.6	0.5	1.5	1.2	1.9	16	53	27	4
2010	2303	1.6	0.5	1.5	1.2	1.9	16	53	27	4

The corrected calcium phosphate product had remained relatively stable for last 5 years in both HD and PD patients. About 47% of PD patients had corrected calcium phosphate product  $<3.5$   $\text{mmol}^2/\text{L}^2$  compared to 34% in HD patients. Overall there was a positive trend in calcium phosphate product with higher percentage of HD and PD patients achieving corrected calcium phosphate product  $<3.5$   $\text{mmol}^2/\text{L}^2$  and fewer patients with corrected calcium phosphate product  $\geq 5.5$   $\text{mmol}^2/\text{L}^2$ . (Tables and Figures 9.2.5 and 9.2.6)

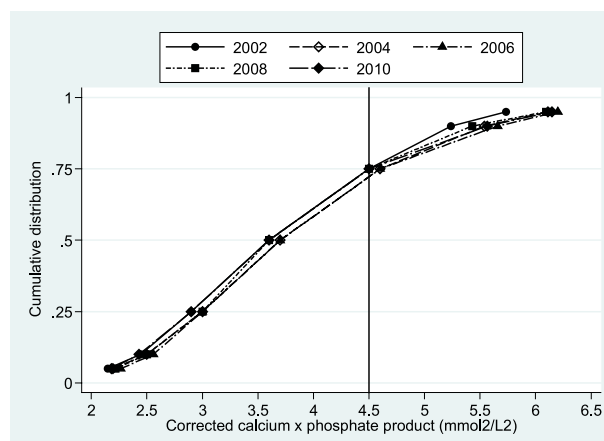
**Table 9.2.5:** Distribution of corrected calcium x phosphate product, HD patients 2001-2010

Year	Number of patients	mean	SD	Median	LQ	UQ	Percent patients with calcium phosphate product:			
							$<3.5$ $\text{mmol}^2/\text{L}^2$	$\geq 3.5$ & $<4.5$ $\text{mmol}^2/\text{L}^2$	$\geq 4.5$ & $<5.5$ $\text{mmol}^2/\text{L}^2$	$\geq 5.5$ $\text{mmol}^2/\text{L}^2$
2001	4555	4.3	1.3	4.2	3.4	5.2	27	31	24	18
2002	5403	4.4	1.3	4.3	3.4	5.2	27	31	24	19
2003	6383	4.2	1.3	4.1	3.3	5.1	30	31	23	16
2004	7414	4.2	1.3	4.1	3.3	5	32	32	22	15
2005	8496	4	1.3	3.9	3.2	4.8	36	32	20	12
2006	10758	4	1.2	3.8	3.1	4.7	38	32	19	11
2007	12172	3.9	1.2	3.8	3.1	4.6	38	33	19	10
2008	14360	3.9	1.2	3.8	3.1	4.6	39	33	19	9
2009	16714	4	1.2	3.9	3.2	4.7	36	34	20	11
2010	18295	4	1.2	3.9	3.2	4.8	34	34	21	11

**Figure 9.2.5:** Cumulative distribution of corrected calcium x phosphate product, HD patients 2001-2010



**Figure 9.2.6:** Cumulative distribution of corrected calcium x phosphate product, PD patients 2001-2010



**Table 9.2.6:** Distribution of corrected calcium x phosphate product, PD patients 2001-2010

Year	Number of patients	mean	SD	Median	LQ	UQ	Percent patients with calcium phosphate product:			
							$<3.5$ $\text{mmol}^2/\text{L}^2$	$\geq 3.5$ & $<4.5$ $\text{mmol}^2/\text{L}^2$	$\geq 4.5$ & $<5.5$ $\text{mmol}^2/\text{L}^2$	$\geq 5.5$ $\text{mmol}^2/\text{L}^2$
2001	723	3.8	1.1	3.6	2.9	4.5	46	30	18	7
2002	856	3.8	1.2	3.6	2.9	4.5	45	29	18	8
2003	1162	3.9	1.2	3.7	3	4.6	43	29	17	10
2004	1274	4	1.2	3.8	3	4.7	41	30	18	12
2005	1333	3.9	1.3	3.7	3	4.6	43	29	17	11
2006	1494	3.9	1.2	3.7	3.1	4.6	43	31	17	9
2007	1745	3.8	1.2	3.6	3	4.5	46	29	15	10
2008	2009	3.8	1.2	3.6	3	4.5	47	28	15	10
2009	2130	3.8	1.2	3.6	2.9	4.5	46	29	15	11
2010	2289	3.8	1.2	3.6	2.9	4.5	47	29	15	10

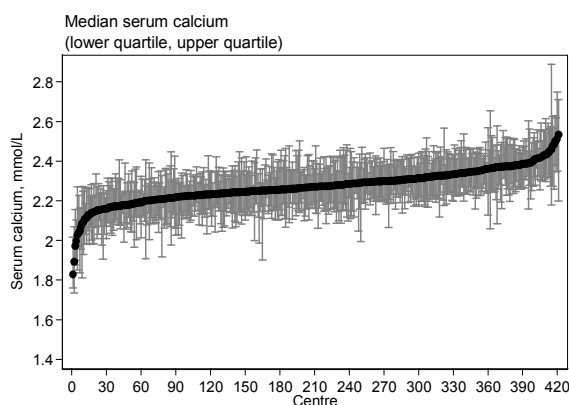
There was wide variation in corrected serum calcium level among both HD and PD centres. The median corrected serum calcium level among 421 HD centres was 2.3 mmol/l (ranged from 1.8 to 2.5 mmol/l) in year 2010 and these figures had remained quite stable for the last 10 years. (Table 9.2.7 and Figure 9.2.7a). The median corrected serum calcium level among 25 PD centres was 2.4mmol/l (ranged from 2.2 to 2.5 mmol/l) and again this range is relatively static. (Table 9.2.8 and Figure 9.2.8a). PD patients had slightly higher median corrected serum calcium level but smaller variation compared to HD patients.

**Table 9.2.7:** Variation in corrected serum calcium level among HD centres, 2010

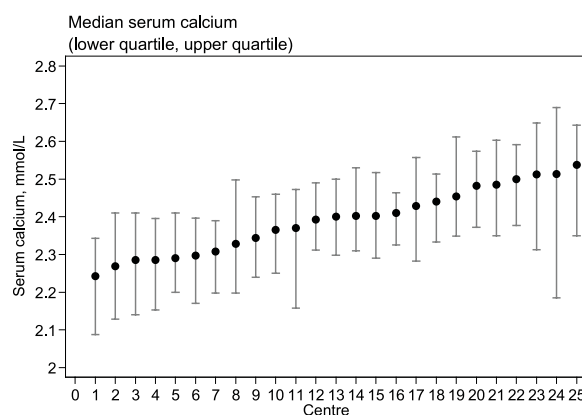
a) median serum calcium level among HD patients

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	116	2	2.1	2.3	2.3	2.4	2.5	2.6
2002	138	1.9	2.1	2.3	2.3	2.4	2.5	2.6
2003	174	2	2.1	2.2	2.3	2.4	2.5	2.5
2004	203	1.9	2.1	2.2	2.3	2.4	2.4	2.5
2005	229	1.8	2	2.2	2.3	2.4	2.4	2.5
2006	281	1.9	2.1	2.2	2.3	2.3	2.4	2.5
2007	313	1.8	2	2.2	2.2	2.3	2.4	2.5
2008	357	1.8	2.1	2.2	2.2	2.3	2.4	2.6
2009	397	1.5	2.1	2.2	2.3	2.3	2.4	2.6
2010	421	1.8	2.2	2.2	2.3	2.3	2.4	2.5

**Figure 9.2.7(a):** Variation in median serum calcium among HD patients, HD centres, 2010



**Figure 9.2.8(a):** Variation in median serum calcium level among PD patients, PD centres, 2010



**Table 9.2.8:** Variation in corrected serum calcium level among PD centres, 2010

a) median serum calcium level among PD patients

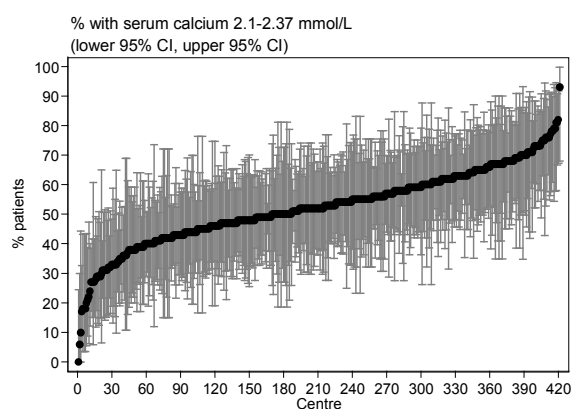
Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	12	2.3	2.3	2.4	2.5	2.5	2.6	2.6
2002	15	2.4	2.4	2.4	2.5	2.5	2.6	2.6
2003	18	2.2	2.2	2.4	2.4	2.5	2.6	2.6
2004	18	2.3	2.3	2.4	2.4	2.5	2.5	2.5
2005	19	2.2	2.2	2.4	2.4	2.5	2.6	2.6
2006	22	2.2	2.2	2.3	2.4	2.4	2.5	2.6
2007	22	2.2	2.2	2.3	2.3	2.4	2.4	2.5
2008	23	2.2	2.2	2.3	2.4	2.4	2.6	2.6
2009	23	2.2	2.3	2.3	2.3	2.4	2.5	2.6
2010	25	2.2	2.3	2.3	2.4	2.5	2.5	2.5

There was great centre variation among the HD and PD centres with regards to the proportion of patients achieving the normal range of corrected calcium level of 2.1 to 2.37 mmol/l; it ranged from 0 to 93% for HD centres and 15-58% for PD centres. The median was 52% for HD centres (Table and Figure 9.2.7b) and 35% for CAPD centres (Table and Figure 9.2.8b). The variation is smaller among PD centres compared to HD centres.

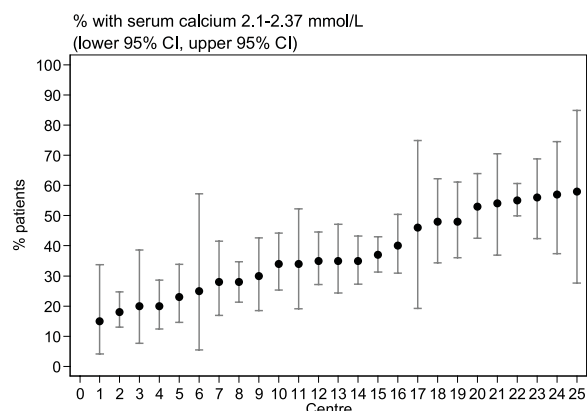
**Table 9.2.7(b):** Proportion of patients with serum calcium 2.1 to 2.37 mmol/L, HD centres, 2010

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	116	7	11	30	39.5	50	64	87
2002	138	5	17	33	44	53	66	71
2003	174	13	24	36	46.5	56	70	92
2004	203	8	20	37	47	58	71	85
2005	229	0	19	39	50	56	70	90
2006	281	13	31	41	50	60	72	90
2007	313	9	29	44	52	60	73	91
2008	357	9	29	46	54	60	74	100
2009	397	0	27	44	53	60	71	92
2010	421	0	31	45	52	61	73	93

**Figure 9.2.7(b):** Variation in proportion of patients with serum calcium 2.1 to 2.37 mmol/L, HD centres, 2010



**Figure 9.2.8(b):** Variation in proportion of patients with serum calcium 2.1 to 2.37 mmol/L, PD centres, 2010



**Table 9.2.8(b):** Proportion of patients with serum calcium 2.1 to 2.37 mmol/L, PD centres

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	12	12	12	17	23.5	34.5	38	38
2002	15	12	12	20	25	34	41	41
2003	18	9	9	19	32	39	58	58
2004	18	11	11	18	24.5	31	53	53
2005	19	17	17	25	35	41	51	51
2006	22	16	25	35	42.5	49	60	76
2007	22	20	23	33	45	50	62	63
2008	23	9	14	30	45	53	58	65
2009	23	12	13	31	40	51	58	65
2010	25	15	18	28	35	48	57	58

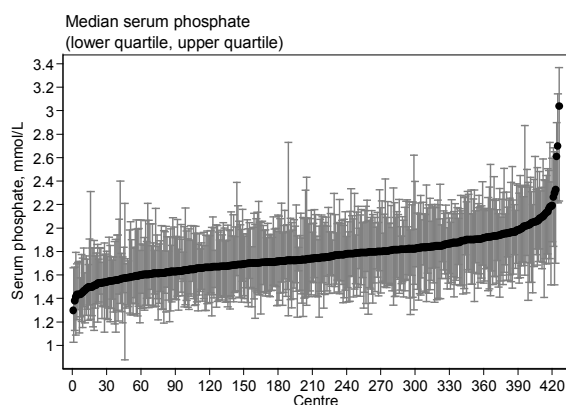
There was also wide centre variation in serum phosphate level among HD centres and PD centres (Table and Figures 9.2.9a and 9.2.10a). PD patients seemed to have better phosphate control compared to HD patients. 51% of PD centres achieved the recommended target of serum phosphate level 1.13 – 1.78 mmol/l compared to 46% of HD centres. There was a great variation among the HD centres with regards to the proportion of patients with serum phosphate 1.13 – 1.78 mmol/l, ranging from 0 to 76% while the range was narrower in PD centres which was 34-67% (Table and Figures 9.2.9b and 9.2.10b).

**Table 9.2.9:** Variation in serum phosphate level among HD centres, 2010

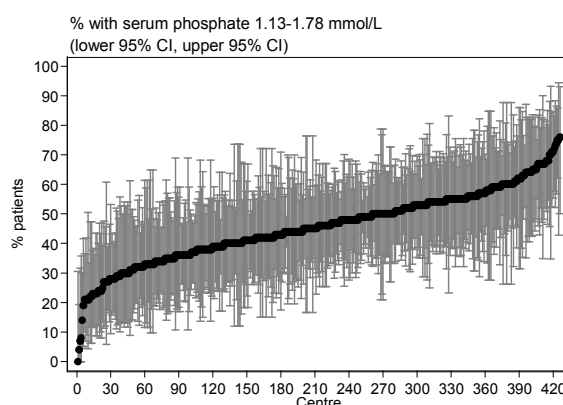
a). Median serum phosphate level among HD patients

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	119	1.3	1.5	1.7	1.8	1.9	2.1	2.4
2002	145	1.3	1.5	1.8	1.9	2	2.2	2.4
2003	178	0.9	1.5	1.7	1.8	1.9	2.2	2.4
2004	204	1.4	1.5	1.7	1.8	1.9	2.1	2.3
2005	232	0.9	1.4	1.6	1.8	1.9	2.1	2.2
2006	285	0.9	1.5	1.6	1.7	1.8	2	2.3
2007	315	1	1.4	1.6	1.7	1.8	2	2.3
2008	361	1.3	1.5	1.6	1.7	1.8	2	2.5
2009	401	1.1	1.5	1.6	1.7	1.8	2	2.3
2010	426	1.3	1.5	1.7	1.7	1.8	2.1	3

**Figure 9.2.9(a):** Variation in median serum phosphate level among HD patients, HD centres, 2010



**Figure 9.2.9(b):** Variation in proportion of patients with serum phosphate 1.13-1.78 mmol/L, HD centres, 2010



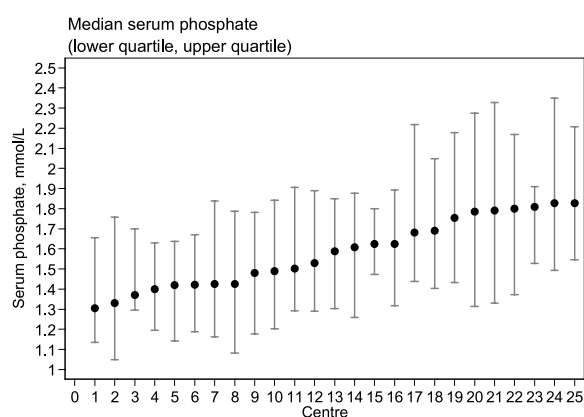
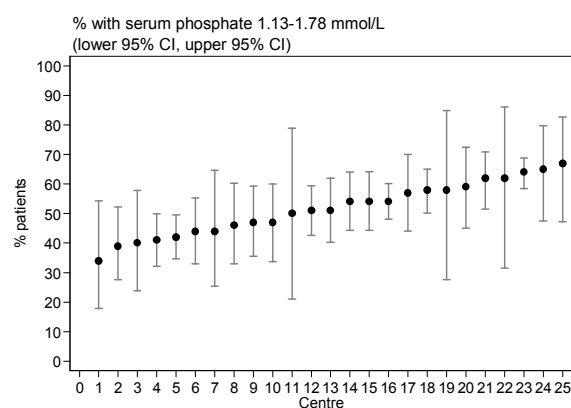
(b) Proportion of patients with serum phosphate 1.13-1.78 mmol/L, HD centres, 2010

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	119	0	17	32	39	47	62	67
2002	145	8	16	30	37	46	67	91
2003	178	9	19	31	40	48	67	93
2004	204	0	17	31	41	50	65	92
2005	232	10	23	36	43	53	70	90
2006	285	8	26	39	46	54	70	93
2007	315	20	29	39	47	54	67	92
2008	361	12	29	39	48	56	67	93
2009	401	6	26	39	47	54	66	82
2010	426	0	24	38	46	54	65	76

**Table 9.2.10:** Variation in serum phosphate levels among PD centres, 2001 - 2010

a). Median serum phosphate level among PD patients

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	12	1.3	1.3	1.4	1.5	1.7	1.9	1.9
2002	15	1.4	1.4	1.4	1.5	1.6	2.1	2.1
2003	18	1.3	1.3	1.5	1.5	1.6	1.7	1.7
2004	18	1.3	1.3	1.5	1.5	1.7	1.8	1.8
2005	19	1.4	1.4	1.5	1.5	1.7	1.9	1.9
2006	22	1.3	1.4	1.5	1.6	1.7	1.8	1.9
2007	22	1.3	1.4	1.5	1.6	1.7	1.9	1.9
2008	23	1.3	1.4	1.5	1.6	1.8	1.8	2.1
2009	23	1.3	1.4	1.5	1.6	1.7	1.9	2.2
2010	25	1.3	1.3	1.4	1.6	1.8	1.8	1.8

**Figure 9.2.10(a):** Variation in median serum phosphate level among PD patients, PD centres 2010**Figure 9.2.10(b):** Variation in proportion of patients with serum phosphate 1.13-1.78 mmol/L, PD centres 2010**Table 9.2.10(b):** Proportion of patients with serum phosphate 1.13-1.78 mmol/L, PD centres 2001 - 2010

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	12	42	42	48.5	54	58	77	77
2002	15	43	43	47	53	60	83	83
2003	18	43	43	52	54	58	77	77
2004	18	37	37	49	52.5	60	76	76
2005	19	38	38	46	52	58	76	76
2006	22	41	44	48	52.5	58	66	68
2007	22	39	43	48	54	57	73	78
2008	23	30	39	47	53	60	65	71
2009	23	20	39	48	52	58	66	75
2010	25	34	39	44	51	58	65	67

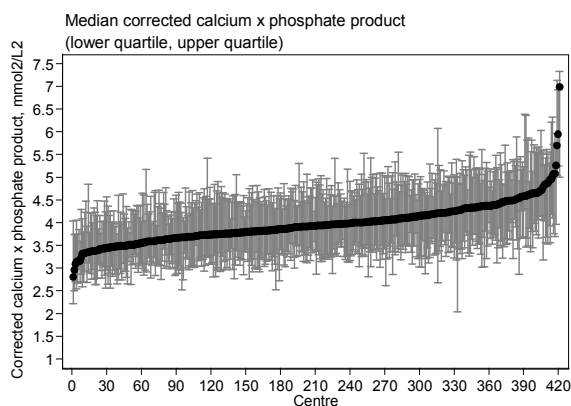
In 2010, the corrected serum calcium phosphate product among 421 HD centres ranged from 2.8 to 7.0 with median of 3.9 mmol/l (Tables 9.2.11 and Figure 9.2.11a). The corrected serum calcium phosphate product among 25 CAPD centres ranged from 3.1 to 4.6 mmol/l with median of 3.8 mmol/l (Tables 9.2.12 and Figure 9.2.12a). There was wider variation of corrected serum calcium phosphate product among HD centres compared to PD centres.

**Table 9.2.11:** Variation in corrected calcium x phosphate product HD centres, 2001-2010

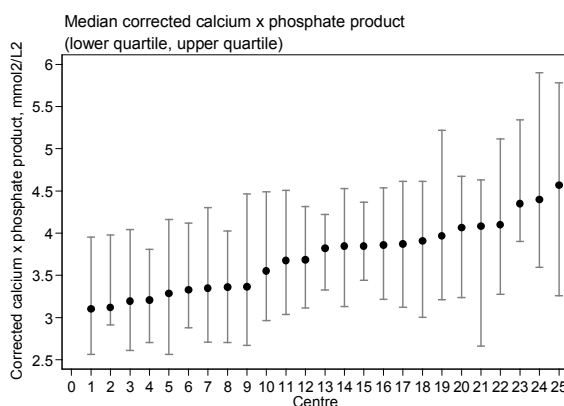
a) median corrected calcium x phosphate product among HD patients

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	113	2.9	3.6	3.9	4.2	4.6	5.2	6.0
2002	138	2.9	3.5	4	4.3	4.6	5.2	5.9
2003	174	2.2	3.3	3.8	4.1	4.5	5.0	5.5
2004	201	2.9	3.4	3.8	4.1	4.4	4.9	5.6
2005	223	2.1	3.2	3.6	3.9	4.2	4.7	5.6
2006	279	1.8	3.2	3.6	3.9	4.2	4.6	5.2
2007	310	2.3	3.2	3.6	3.8	4.1	4.5	5.1
2008	354	2.7	3.2	3.6	3.8	4.1	4.5	5.7
2009	394	2.6	3.3	3.6	3.9	4.1	4.7	6.0
2010	421	2.8	3.4	3.7	3.9	4.2	4.6	7.0

**Figure 9.2.11(a):** Variation in median corrected calcium x phosphate product among HD patients, HD centres, 2010



**Figure 9.2.12(a):** Variation in median corrected calcium x phosphate product among PD centres, to 2010



**Table 9.2.12:** Variation in corrected calcium x phosphate product among PD centres, 2001-2010

a) median corrected calcium x phosphate product among PD patients

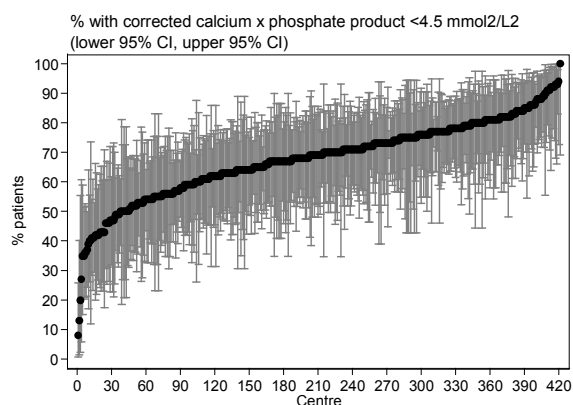
Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	12	3.1	3.1	3.4	3.7	3.9	4.3	4.3
2002	15	3.3	3.3	3.4	3.6	4	4.9	4.9
2003	18	3.2	3.2	3.4	3.7	3.9	4.1	4.1
2004	18	3.2	3.2	3.5	3.8	4	4.4	4.4
2005	19	3.3	3.3	3.5	3.7	4	4.3	4.3
2006	22	3	3.3	3.6	3.7	4	4.3	4.4
2007	22	3.1	3.3	3.5	3.8	4.2	4.3	4.3
2008	23	3.1	3.2	3.4	3.7	4.1	4.6	5.1
2009	23	3.3	3.3	3.5	3.7	3.9	4.6	4.8
2010	25	3.1	3.1	3.3	3.8	4	4.4	4.6

With regards to the proportion of patients with corrected calcium phosphate product less than  $4.5 \text{ mmol}^2/\text{L}^2$ , the median was 69% for HD centres (Table and Figure 9.2.11b) and 75% for PD centres (Table and Figure 9.2.12 b). There was again a great variation between the HD centres with regards to the proportion of patients with calcium phosphate product less than  $4.5 \text{ mmol}^2/\text{L}^2$ , ranging from 8% to 100%. (Table 9.2.11b). Among the PD centres, the proportion of patients with calcium phosphate product less than  $4.5 \text{ mmol}^2/\text{L}^2$ , ranged from 48% to 89% (Table 9.2.12b).

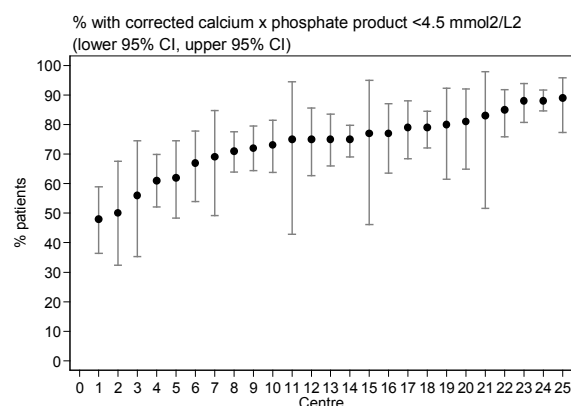
**Table 9.2.11(b):** Proportion of patients with corrected calcium x phosphate  $< 4.5 \text{ mmol}^2/\text{L}^2$ , HD centres

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	113	19	35	47	57	70	81	91
2002	138	17	32	48	57	68	90	100
2003	174	25	33	50	61	71	84	100
2004	201	15	38	53	64	72	88	100
2005	223	24	44	58	69	77	91	100
2006	279	30	45	61	70	79	91	100
2007	310	33	48	63	72.5	80	92	100
2008	354	26	50	65	72	81	92	100
2009	394	27	43	62	71	79	89	100
2010	421	8	43	60	69	77	87	100

**Figure 9.2.11(b):** Variation in proportion of patients with corrected calcium x phosphate product  $< 4.5 \text{ mmol}^2/\text{L}^2$ , HD centres 2010



**Figure 9.2.12(b):** Variation in proportion of patients with corrected calcium x phosphate product  $< 4.5 \text{ mmol}^2/\text{L}^2$ , PD centres, 2010



**Table 9.2.12(b):** Proportion of patients with corrected calcium x phosphate  $< 4.5 \text{ mmol}^2/\text{L}^2$ , PD centres

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	12	50	50	71.5	75	81.5	84	84
2002	15	43	43	65	78	82	88	88
2003	18	61	61	64	74.5	82	89	89
2004	18	57	57	66	72	79	89	89
2005	19	54	54	63	73	78	85	85
2006	22	53	56	67	71	79	88	96
2007	22	51	56	64	72.5	79	88	98
2008	23	40	43	63	70	81	89	97
2009	23	40	48	64	76	80	85	86
2010	25	48	50	69	75	80	88	89



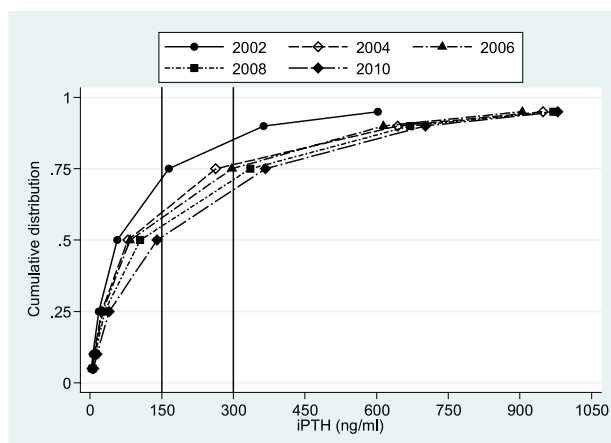
### SECTION 9.3: SERUM PARATHYROID HORMONE CONTROL

The intact parathyroid hormone (iPTH) level was on the rise between 2001 to 2009 but it has decreased for the first time in 2010 for both HD and PD patients. PD patients had relatively higher level of iPTH compared to HD patients. The mean iPTH level for HD patients was 234.1ng/ml with the median of 97.2ng/ml (Table and Figure 9.3.1a). For PD patients, the mean iPTH level was 261.5ng/ml with the median of 163ng/ml. (Table and Figure 9.3.2b). There was higher percentage of HD patients with iPTH level less than 150 ng/ml (59%) compared to PD patients (48%). However, there were more PD patients with iPTH  $\geq 150$  &  $\leq 300$  ng/ml than HD patients (20% vs 15%). Patients with diabetes had relatively lower iPTH level compared to patients without diabetes in both HD and PD populations, with the mean of 187.5 ng/ml vs 273.2 ng/ml for HD patients and 197.4ng/ml vs 295.6ng/ml for PD patients. (Table and Figure 9.3.1b, 9.3.1c, 9.3.2b and 9.3.2c)

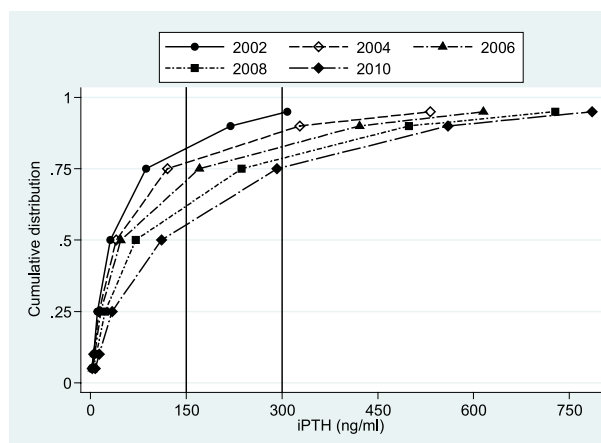
**Table 9.3.1(a):** Distribution of iPTH, HD patients, 2001-2010

Year	Number of Patients	Mean	SD	Median	LQ	UQ	Percent patients with iPTH:			
							<150 ng/ml	$\geq 150$ & $\leq 300$ ng/ml	>300 & $\leq 500$ ng/ml	>500 ng/ml
2001	2760	141.2	219.5	57	18	164.8	73	15	6	7
2002	3391	161.6	248	64	19	191	70	14	8	8
2003	4068	219.1	328.8	79	24.3	263.3	64	14	9	14
2004	4748	212.1	325.6	74.3	22.6	257.3	65	13	9	13
2005	5826	221.6	312.5	83.8	26.5	297	61	14	11	14
2006	7744	219.1	307.2	88	29	292	61	14	11	13
2007	9151	245.8	332.7	105	30.4	335.5	58	15	12	16
2008	10753	260.8	330.9	127	36	361	54	17	13	17
2009	12642	269.4	337.3	140.1	40	367.1	52	18	13	17
2010	14210	234.1	318.2	97.2	30	317.5	59	15	11	15

**Figure 9.3.1(a):** Cumulative distribution of iPTH, HD, 2001-2010



**Figure 9.3.1(b):** Cumulative distribution of iPTH, diabetic HD patients, 2001-2010

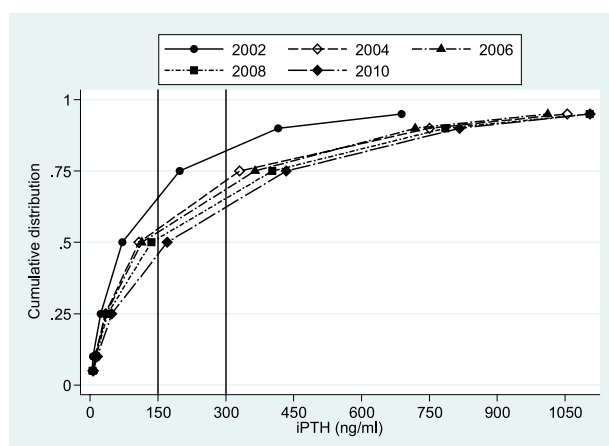
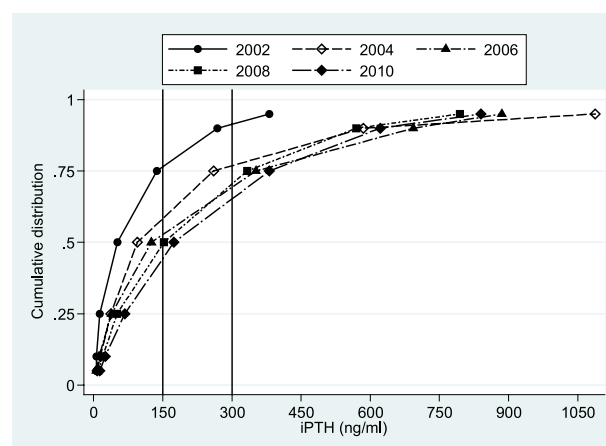


**Table 9.3.1(b):** Distribution of iPTH, diabetic HD patients, 2001-2010

Year	Number of Patients	Mean	SD	Median	LQ	UQ	Percent patients with iPTH:			
							<150 ng/ml	$\geq 150$ & $\leq 300$ ng/ml	>300 & $\leq 500$ ng/ml	>500 ng/ml
2001	704	80.6	136	31.2	10.9	87.3	84	11	4	2
2002	938	90.9	157.4	34.9	10.9	97	83	10	4	3
2003	1204	120.1	209.3	40.2	13.3	120.3	79	10	6	5
2004	1532	111.4	193.6	38	14	114.4	80	10	5	5
2005	2107	149.5	246.1	47.4	16.1	170.5	72	12	8	8
2006	3068	155.1	253.3	54	20.8	174	72	12	8	7
2007	3679	183.2	267.5	70.7	23	236.5	66	14	10	10
2008	4592	208.9	275.3	99	29.1	286.9	59	17	12	12
2009	5636	218.2	284	111.1	33.7	292	57	18	12	12
2010	6488	187.5	266.3	74.1	25.7	253.2	64	15	11	10

**Table 9.3.1(c):** Distribution of iPTH, non diabetic HD patients, 2001-2010

Year	Number of Patients	Mean	SD	Median	LQ	UQ	Percent patients with iPTH:			
							<150 ng/ml	≥ 150 & ≤300 ng/ml	>300 & ≤500 ng/ml	>500 ng/ml
2001	2056	162	238.1	71	23.4	198	69	16	7	8
2002	2453	188.7	270.1	84	26	235	65	15	10	10
2003	2864	260.7	359.6	108	33.5	330.5	57	16	10	17
2004	3216	260.1	362.7	102.3	30.5	338.8	58	14	11	17
2005	3719	262.5	337.8	114.1	35.5	364.5	55	15	13	17
2006	4676	261.2	331.3	122.7	39	362	54	16	13	17
2007	5472	287.9	364.1	135.1	38.7	402.8	52	15	13	19
2008	6161	299.5	362.2	155	42.7	418	49	16	14	21
2009	7006	310.6	369.6	170.5	47.8	433.5	47	17	14	21
2010	7722	273.2	351.3	125.6	36	383.5	54	15	12	19

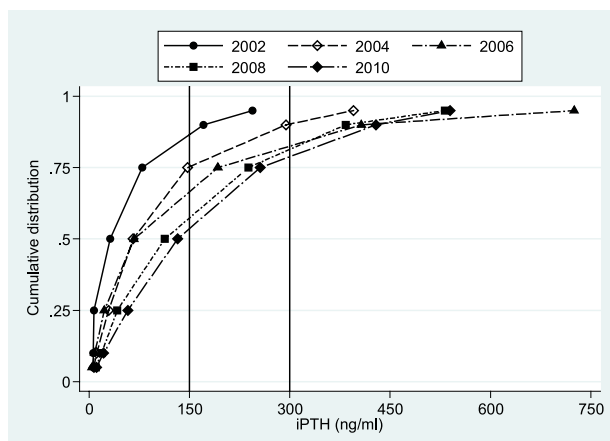
**Figure 9.3.1(c):** Cumulative distribution of iPTH, non diabetic HD patients, 2001-2010**Figure 9.3.2(a):** Cumulative distribution of iPTH, PD patients, 2001-2010**Table 9.3.2(a):** Distribution of iPTH, PD patients, 2001-2010

Year	Number of Patients	Mean	SD	Median	LQ	UQ	Percent patients with iPTH:			
							<150 ng/ml	≥ 150 & ≤300 ng/ml	>300 & ≤500 ng/ml	>500 ng/ml
2001	531	108	155.8	51.5	13.5	137.6	76	15	6	3
2002	681	160.6	219.1	82	26	196	67	17	8	7
2003	938	230.3	340.3	95	37.4	260	61	18	9	12
2004	1115	216.4	302.9	105	39.5	260	60	19	10	11
2005	1071	247.1	306.4	125.3	39	352	54	18	13	15
2006	1265	224.6	271.9	128	41.5	318	54	20	14	12
2007	1436	248.4	297.1	152.5	51	332.8	50	22	15	14
2008	1608	264.2	295.3	170.3	57.3	357.7	46	22	18	15
2009	1824	270.6	292.7	174.2	67.8	381	45	22	16	16
2010	1905	261.5	294.8	163	51	371	48	20	16	16

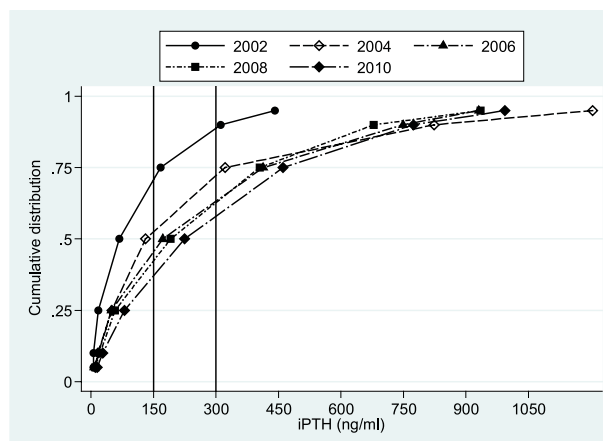
**Table 9.3.2(b):** Distribution of iPTH, diabetic PD patients, 2001-2010

Year	Number of Patients	Mean	SD	Median	LQ	UQ	Percent patients with iPTH:			
							<150 ng/ml	≥ 150 & <300 ng/ml	>300 & <500 ng/ml	>500 ng/ml
2001	159	63.6	87.1	31	6.8	79	88	9	3	1
2002	194	98.5	158.3	52.8	15	125.8	82	12	3	3
2003	312	122.6	179.7	65.6	29	146.8	75	15	6	4
2004	358	127	187.1	63.3	24.1	145	75	15	4	5
2005	348	161.4	241.4	67	22.5	192.3	70	15	8	7
2006	434	149.5	198.4	88.9	32.5	186.5	68	19	8	5
2007	544	176.4	204.6	113	41.8	237.8	58	25	11	6
2008	692	211.3	228.4	141.2	56.3	293.8	51	24	17	8
2009	750	186.8	184.9	132	57.5	255.5	54	26	13	7
2010	661	197.4	216.8	131	42	295	54	21	16	8

**Figure 9.3.2(b):** Cumulative distribution of iPTH, diabetic PD patients, 2001-2010Z



**Figure 9.3.2(c):** Cumulative distribution of iPTH, non diabetic PD patients, 2001-2010



**Table 9.3.2(c):** Distribution of iPTH, non diabetic PD patients, 2001-2010

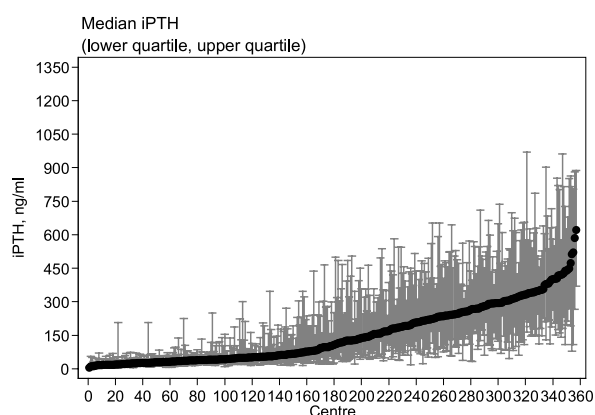
Year	Number of Patients	Mean	SD	Median	LQ	UQ	Percent patients with iPTH:			
							<150 ng/ml	≥ 150 & <300 ng/ml	>300 & <500 ng/ml	>500 ng/ml
2001	372	127	173.9	67.5	17.2	167	72	18	7	4
2002	487	185.3	234.7	100	33	241	62	19	10	9
2003	626	284	385.8	130.8	49.9	321.5	54	19	10	17
2004	757	258.6	336.3	138	50	325	53	20	12	14
2005	723	288.3	325.3	172	48.8	413.5	47	19	15	19
2006	831	263.8	295.9	164	50	386	47	21	16	16
2007	892	292.3	334	191	57.5	404.8	44	20	18	18
2008	916	304.1	331.7	208.4	57.5	422.5	41	20	18	20
2009	1074	329.1	336.7	224.6	80	461	39	20	19	22
2010	1244	295.6	323.8	186.3	56.6	423.7	45	20	15	20

There was wide variation in iPTH level among HD centres and PD centres and the degree of variation seemed to become wider since 2001 especially among HD centres. With regards to the proportion of patients with serum iPTH level in the range 150-300 ng/ml, the median was only 15% for HD centres (Table and Figure 9.3.3b) and 20% for PD centres (Table and Figure 9.3.4b).

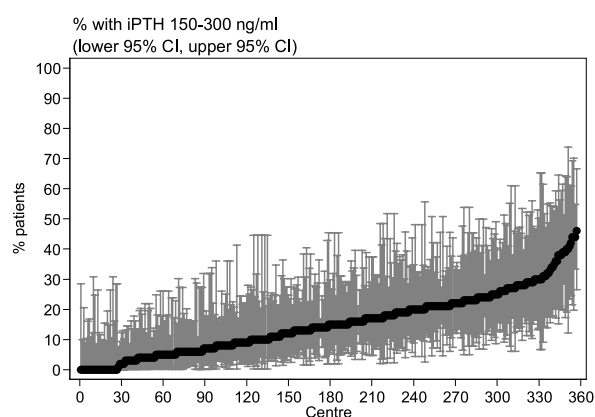
**Table 9.3.3(a):** Variation in iPTH among HD centres 2001-2010

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	71	7.2	10.4	27.9	50.2	80.5	224	543
2002	94	1.4	10.8	28.6	49.5	139	309	660.3
2003	114	4	9.6	35.5	86	193.5	375.2	624.5
2004	136	3.6	12	29.3	74.7	201.5	398.8	708
2005	166	6.1	14.5	38.7	96.1	229	419.2	626.4
2006	219	7.7	15.1	41.4	90.8	204.5	376	632.8
2007	247	11.8	20.4	45.8	117	240	428.8	615
2008	288	8.5	22.4	60.8	140.8	244.6	411	712.5
2009	334	2.6	26.9	63.6	161.1	247.5	416	956.1
2010	357	5.5	18.5	40.8	105.8	243	400.4	621

**Figure 9.3.3(a):** Variation in median iPTH among HD patients, HD centres 2010



**Figure 9.3.3(b):** Variation in proportion of patients with iPTH 150-300ng/ml, HD centres, 2010



**Table 9.3.3(b):** Variation in proportion of patients with iPTH 150-300ng/ml, HD centres, 2001-2010

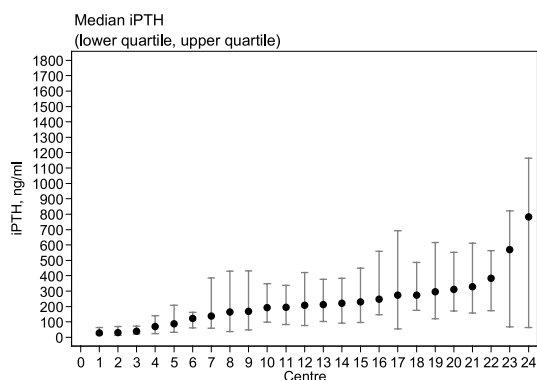
Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	71	0	0	5	10	20	32	40
2002	94	0	0	2	10	22	32	45
2003	114	0	0	6	13.5	21	36	42
2004	136	0	0	5	10	19	33	50
2005	166	0	0	7	14	20	33	47
2006	219	0	0	7	14	20	30	45
2007	247	0	0	9	15	21	30	53
2008	288	0	0	9	16	23	31	44
2009	334	0	0	10	17	25	35	60
2010	357	0	0	7	15	22	34	46

**Table 9.3.4:** Variation in iPTH among PD centres, 2001-2010

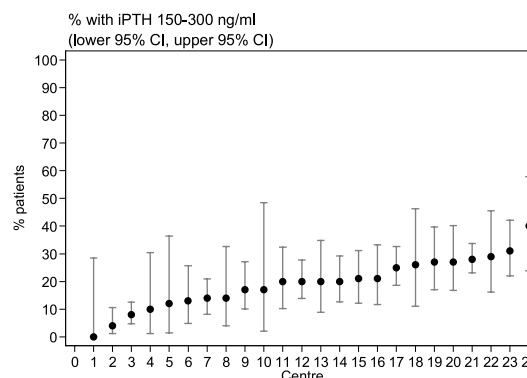
a) Median iPTH among PD patients

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	11	15.4	15.4	42.5	59.5	91	274	274
2002	14	27.3	27.3	50	82.9	107	280.5	280.5
2003	17	22.4	22.4	70	135	175	309.5	309.5
2004	18	41	41	74.5	138.8	169.3	329.6	329.6
2005	18	25.5	25.5	85	140.6	259.5	493.3	493.3
2006	21	34.5	36.9	102.5	166.5	243	367	411
2007	22	26.3	32	107.5	202.1	290.5	440	513.9
2008	22	35	47	132	186.2	310.9	352.3	454.5
2009	22	37.5	56.5	144.5	200.4	285.8	468.8	1047
2010	24	28.5	30.4	129.8	210.8	285.2	570.5	783.2

**Figure 9.3.4(a):** Variation in median iPTH among PD patients, PD centres, 2010



**Figure 9.3.4(b):** Variation in proportion of patients with iPTH 150-300ng/ml, PD centres 2010



**Table 9.3.4(b):** Proportion of patients with iPTH 150-300ng/ml

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	11	0	0	9	14	19	30	30
2002	14	0	0	10	15.5	21	24	24
2003	17	2	2	12	18	22	33	33
2004	18	7	7	14	20	24	30	30
2005	18	0	0	9	15.5	23	31	31
2006	21	5	6	13	20	26	33	40
2007	22	0	3	16	21	27	31	39
2008	22	0	7	15	20.5	26	31	33
2009	22	10	12	17	22	26	28	28
2010	24	0	4	13.5	20	26.5	31	40

## Conclusion

There were no major changes in the type of phosphate binders used for both HD and PD patients. About 91% of HD patients and 88% of PD patients were still taking calcium carbonate as their phosphate binder in 2010. The use of lanthanum as phosphate binder has increased slowly since 2006 whereas the aluminium based phosphate binder has decreased to 0.1%. Calcitriol remained the main vitamin D used in both HD and PD patients and its use is still on the rise. The use of Paricalcitol has also increased slowly in HD patients from 0.29% to 0.79% but its use has decreased from 0.21% in 2006 to 0.10% in 2010 in PD patients. This may be because PD patients had better calcium phosphate control therefore their iPTH level could be controlled using Calcitriol instead of Paricalcitol.

The mean corrected serum calcium level remained slightly lower in the HD patients (2.3 mmol/L) compared to CAPD patients (2.4 mmol/L), however phosphate control continued to be better in CAPD patients with the mean phosphate level of 1.6mmol/L as apposed to 1.8mmol/L in HD patients. The proportion of CAPD patients achieving target serum phosphate 1.13-1.78 mmol/l was 53% compared to 46% in HD patients. More PD patients had serum calcium phosphate product of less than 4.5 mmol<sup>2</sup>/L<sup>2</sup> compared with HD patients (median 75% vs 69%) in 2010.

The intact parathyroid hormone (iPTH) level which had been on the rise since 2001 and peaked at 2009, has appeared to decrease for the first time in 2010 for both HD and PD patients. In addition, the number of patients who underwent parathyroidectomy has continued to decrease since 2006 among both HD and PD patients. This reflects better awareness and management of renal bone disease in our dialysis patients. Interestingly, PD patients had relatively higher level of iPTH despite better calcium phosphate control compared to HD patients and patients with diabetes had lower iPTH level than patients without diabetes in both HD and PD populations.

Overall, the renal bone disease management in our dialysis populations has improved as reflected by decrease of the iPTH level for the first time in 2010. However, there were still wide centre variations especially among HD centres in the management of renal bone disease and the degree of variation seemed to become wider for the last 10 years. This could be partly due to additional new HD centers being set up every year and more patients entering haemodialysis program than PD. Therefore, perhaps we should pay more attention to patient education with regards to low phosphate dietary compliance in their chronic kidney disease stage so that they have less renal bone disease complication when they eventually enter the dialysis program.



CHAPTER 10

**HEPATITIS ON DIALYSIS**

Teo Sue Mei  
Chow Yok Wai  
Clare Tan Hui Hong  
T. Thiruventhiran



## SECTION A: PREVALENCE

Between 2001 and 2010, the annual prevalence of patients with Hepatitis B, remained low and was quite similar comparing HD and PD patients, with ranges from 4% to 6% in HD and from 2 to 5% in PD patients.

The prevalence of Hepatitis C in PD patients remains low annually, while in HD patients there continues to be an annual decline, which implies that dialysis facilities around the country have been consistent in maintaining stringent infection control measures to prevent new HCV seroconversions.

**Table 10.1:** Prevalence of positive HBsAg and positive Anti-HCV at annual survey, HD patients 2001-2010

Year	Number of patients	Prevalence of HBsAg+ (%)	Prevalence of Anti-HCV+ (%)
2001	5187	6	23
2002	6106	5	20
2003	6977	5	19
2004	7618	5	17
2005	8957	4	14
2006	11295	5	12
2007	12496	5	11
2008	14951	4	9
2009	17354	4	8
2010	18575	4	7

**Table 10.2:** Prevalence of positive HBsAg and positive Anti-HCV at annual survey, PD patients 2001-2010

Year	Number of patients	Prevalence of HBsAg+ (%)	Prevalence of Anti-HCV+ (%)
2001	781	2	3
2002	891	3	4
2003	1223	3	4
2004	1200	4	5
2005	1318	4	5
2006	1494	5	4
2007	1731	5	4
2008	2017	4	3
2009	2144	4	3
2010	2280	3	3

## SECTION B: CENTRE VARIATION

There was larger center to center variation among HD compared to PD centers in terms of the proportion of Hepatitis B patients. Some smaller HD centers may practice the policy of not accepting Hepatitis B patients and therefore Hepatitis B patients tend to be segregated to the larger and older HD centers.

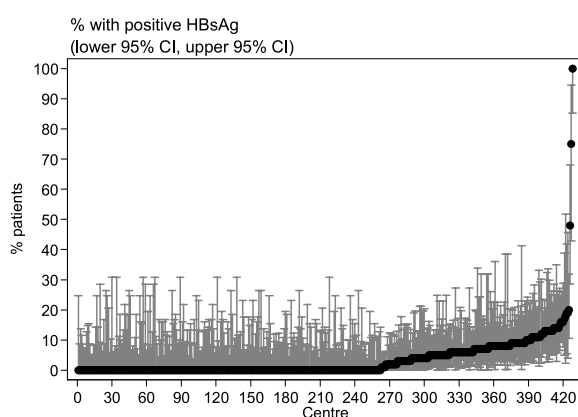
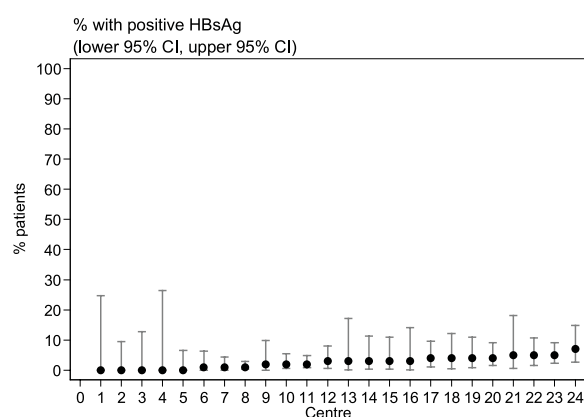
The variation in prevalence of HCV patients among the HD centers was even wider compared to Hepatitis B. This reflects the diversities in infection control protocols among centers. There should be regular audits to ensure standardization and consistent implementation of stringent infection control protocols to further reduce the incidence of new HCV seroconversions.

**Table 10.3:** Variation in Proportion of patients with positive HBsAg at annual survey among HD centres, 2001-2010

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	127	0	0	0	5	9	16	90
2002	153	0	0	0	3	8	14	26
2003	184	0	0	0	3	8	15	73
2004	208	0	0	0	3	7	15	92
2005	237	0	0	0	2	6	16	100
2006	289	0	0	0	0	6	16	94
2007	316	0	0	0	0	6	15	100
2008	364	0	0	0	0	6	12	100
2009	400	0	0	0	0	5	13	96
2010	428	0	0	0	0	5.5	13	100

**Table 10.4:** Variation in Proportion of patients with positive HBsAg at annual survey among PD centres, 2001-2010

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	12	0	0	0	2	3	9	9
2002	15	0	0	1	3	6	18	18
2003	18	0	0	2	4	6	8	8
2004	18	0	0	1	3	5	11	11
2005	19	0	0	1	3	5	10	10
2006	22	0	0	2	4	6	9	13
2007	22	0	0	2	4	6	8	11
2008	23	0	0	1	4	5	10	13
2009	23	0	0	1	4	5	9	10
2010	24	0	0	1	3	4	5	7

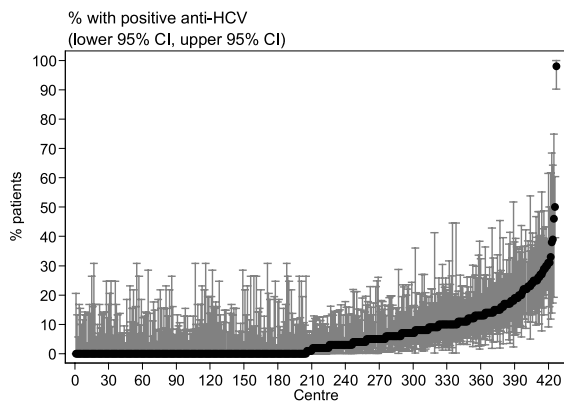
**Figure 10.3:** Variation in Proportion of patients with positive HBsAg among HD centres, 2010**Figure 10.4:** Variation in Proportion of patients with positive HBsAg among PD centres, 2010**Table 10.5:** Variation in Proportion of patients with positive anti-HCV at annual survey among HD centres, 2001-2010

Year	Number of centre	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	127	0	0	5	17	31	65	88
2002	153	0	0	5	14	26	54	94
2003	184	0	0	6	13	25	50	90
2004	210	0	0	4	11.5	25	50	100
2005	239	0	0	0	10	20	38	98
2006	288	0	0	0	8	17.5	41	98
2007	315	0	0	0	7	14	35	100
2008	364	0	0	0	5	12	29	100
2009	400	0	0	0	3	10	26	98
2010	427	0	0	0	2	9	24	98

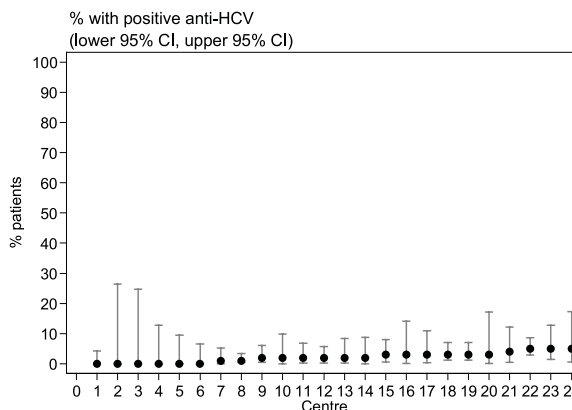
**Table 10.6:** Variation in Proportion of patients with positive anti-HCV at annual survey among PD centres, 2001-2010

Year	Number of centre	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
2001	12	0	0	0	3	4	7	7
2002	15	0	0	0	3	8	11	11
2003	18	0	0	1	4.5	7	9	9
2004	18	0	0	1	4.5	7	10	10
2005	19	0	0	2	4	8	11	11
2006	22	0	0	1	2.5	6	8	11
2007	22	0	0	1	2.5	6	8	9
2008	23	0	0	0	3	4	5	9
2009	23	0	0	0	2	3	5	8
2010	24	0	0	0.5	2	3	5	5

**Figure 10.5:** Variation in Proportion of patients with positive anti-HCV among HD centres, 2010



**Figure 10.6:** Variation in Proportion of patients with positive anti-HCV among PD centres, 2010



**SECTION C: SEROCONVERSION RISKS**

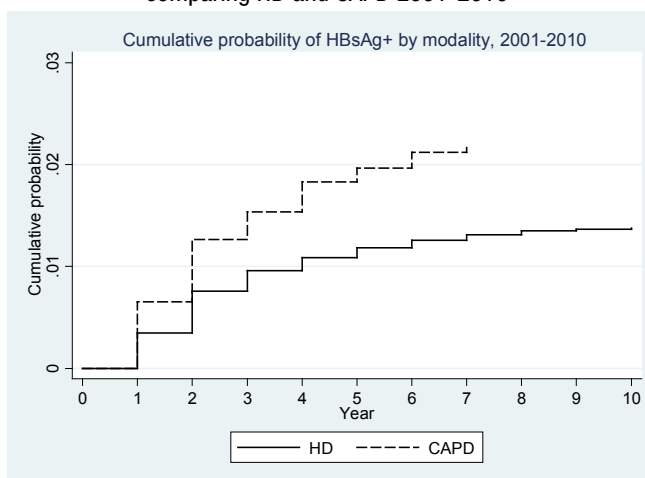
As shown in Table 10.7 (a) and Figure 10.7 (b), the cumulative risk of HBV infection was 2.17% at 7 years on PD and 1.18% for HD. The risks were low, and appeared to be slightly higher in patients on PD. This could be due to the much smaller PD population compare to the HD population. Another contributing factor could be that patients undergoing HD were more likely to get vaccinated against Hepatitis B as compared to patients undergoing PD. There should be a standard practice that all predialysis patients get Hepatitis B vaccination before starting dialysis regardless of dialysis modality.

The cumulative risk of HCV infection was 2.01% at 7 years on PD and is only slightly higher at 3.16% for HD. The risk of HCV seroconversion on HD has decreased markedly as compared to the 2003 NRR report where the risk of HCV infection on HD was 15% at 5 years. [1].

**Table 10.7 (a)** Cumulative risk of sero-conversion to HBsAg positive among sero-negative patients at entry into dialysis, comparing HD and CAPD 2001-2010

Modality	CAPD		HD	
	Interval (years)	% Cumulative probability	SE*	% Cumulative probability
1	0.65	0.19	0.35	0.10
2	1.26	0.18	0.76	0.12
3	1.53	0.08	0.96	0.06
4	1.83	0.09	1.09	0.04
5	1.96	0.04	1.18	0.03
6	2.12	0.05	1.26	0.02
7	2.17	0.02	1.31	0.02
8	-	-	1.35	0.01
9	-	-	1.37	0.01
10	-	-	1.38	0.00

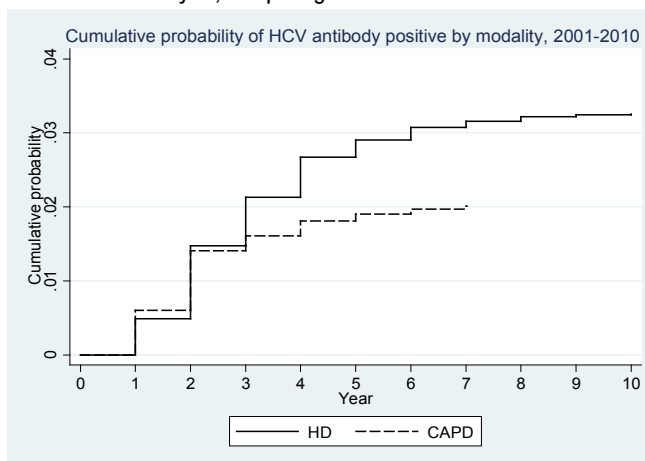
**Figure 10.7 (a)** Cumulative risk of sero-conversion to HBsAg positive among sero-negative patients at entry into dialysis, comparing HD and CAPD 2001-2010



**Table 10.7 (b)** Cumulative risk of sero-conversion to anti HCV antibody positive among sero-negative patients at entry into dialysis, comparing HD and CAPD 2001-2010

Modality	CAPD		HD	
	Interval (years)	% Cumulative probability	SE*	% Cumulative probability
1	0.60	0.18	0.49	0.14
2	1.41	0.24	1.47	0.28
3	1.61	0.06	2.13	0.19
4	1.81	0.06	2.67	0.16
5	1.90	0.03	2.90	0.07
6	1.97	0.02	3.07	0.05
7	2.01	0.02	3.16	0.02
8	-	-	3.22	0.02
9	-	-	3.24	0.01
10	-	-	3.26	0.00

**Figure 10.7 (b)** Cumulative risk of sero-conversion to anti HCV antibody positive among sero-negative patients at entry into dialysis, comparing HD and CAPD 2001-2010



Tables 10.8 (a) and 10.8 (b) looked at the risk for HCV seroconversion in relation to patient characteristics or HD practices. Higher seroconversion risks were seen in PD patients who switched modality from HD, while in HD, patients at higher risks were those who had previous renal transplant and history of blood transfusion. In terms of patient demographics, there was a trend for increased risk among men and older age groups.

In terms of HD practices, centers which still use the manual dialyzer reprocessing systems run significantly higher risk of seroconversion. However a significantly lower seroconversion risk was seen with dialyzer reuse of > 10 times. This may be due to the fact that most centers which practice dialyzer reuse of > 10 times are probably also using fully automated reprocessing systems.

**Table 10.8 (a):** Risk factors in relation to HD practices for seroconversion to anti-HCV positive among sero-negative patients 2001-2010

Risk factor	Number of patients	Risk Ratio	95% CI	p-value
Assistance to Perform HD				
• Self care <sup>(ref*)</sup>	119	1.00		
• Partial self care	95	0.82	(0.62;1.09)	0.165
• Completely assisted	643	0.96	(0.78;1.19)	0.718
Dialyzer Reuse				
• less than 10 <sup>(ref*)</sup>	490	1.00		
• more than 10	362	0.51	(0.44;0.59)	<0.001
Dialyzer Reprocessing System				
• Fully Auto <sup>(ref*)</sup>	545	1.00		
• Semi Auto	98	1.22	(0.99;1.52)	0.067
• Manual	80	1.58	(1.25;2)	<0.001
Age				
• ≤20 <sup>(ref*)</sup>	7	1.00		
• 21-40	91	1.41	(0.62;3.19)	0.414
• 41-60	370	1.57	(0.7;3.52)	0.269
• >60	392	1.74	(0.78;3.9)	0.179
Gender				
• Female <sup>(ref*)</sup>	350	1.00		
• Male	510	1.17	(1.01;1.36)	0.032
Diabetes				
• No <sup>(ref*)</sup>	407	1.00		
• Yes	453	0.83	(0.72;0.97)	0.018
Previous Renal Transplant				
• No <sup>(ref*)</sup>	834	1.00		
• Yes	26	2.08	(1.39;3.11)	<0.001
History of Blood Transfusion				
• No <sup>(ref*)</sup>	501	1.00		
• Yes	359	1.37	(1.18;1.58)	<0.001

**Table 10.8 (b):** Risk factors for seroconversion to anti-HCV positive among sero-negative patients in PD 2001-2010

Risk factor	Number of patients	Risk Ratio	95% CI	p-value
Age				
• ≤20 (ref*)	7	1.00		
• 21-40	18	1.36	(0.57;3.23)	0.489
• 41-60	43	1.51	(0.67;3.42)	0.318
• >60	23	0.86	(0.36;2.07)	0.744
Gender				
• Female (ref*)	35	1.00		
• Male	56	1.69	(1.11;2.57)	0.015
Diabetes				
• No (ref*)	60	1.00		
• Yes	31	0.63	(0.4;1.01)	0.056
Switch from HD to PD				
• No (ref*)	67	1.00		
• Yes	24	2.25	(1.4;3.6)	0.001
Previous Renal Transplant				
• No (ref*)	90	1.00		
• Yes	1	0.27	(0.04;1.92)	0.190
History of Blood Transfusion				
• No (ref*)	48	1.00		
• Yes	43	1.34	(0.88;2.04)	0.170

### Conclusion

Nosocomial transmission in HD remains the most common cause of the higher HCV prevalence in HD compared to PD. However, there has been significant improvement over the years with the consistent decline in annual prevalence of HCV and the lower cumulative risk of seroconversion in HD. We need to continue with our efforts to reduce the epidemic of hepatitis in dialysis patients with continuous surveillance, early reporting and standardization of strict infection control protocol among HD facilities nationwide.

### Reference

1. Chapter 11: Hepatitis on Dialysis. 11<sup>th</sup> Report of the Malaysian Dialysis and Transplant Registry 2003. Edited by T.O Lim, Y.N Lim.

CHAPTER 11

**HAEMODIALYSIS  
PRACTICES**

Tan Chwee Choon  
Norleen bt Zulkarnain Sim  
Rafidah Abdullah  
Shahnaz Shah Firdaus Khan

## SECTION 11.1: VASCULAR ACCESS AND ITS COMPLICATIONS

The proportion of patients with native vascular access has declined from 96% in 2001 to 90% in 2010. The number of patients on cuffed or non-cuffed central venous catheters has increased over the past 10 years.

**Table 11.1.1:** Vascular Access on Haemodialysis, 2001-2010

Access types	2001		2002		2003		2004		2005	
	n	%	n	%	n	%	n	%	n	%
Wrist AVF	4049	79	4680	78	5249	75	5891	73	6405	69
BCF*	897	17	1068	18	1359	20	1693	21	2169	23
Venous graft	19	0	14	0	23	0	41	1	30	0
Artificial graft	64	1	78	1	113	2	149	2	221	2
Permanent CVC	25	1	43	1	61	1	99	1	179	2
Temporary CVC*	90	2	138	2	179	3	233	3	266	3
Temporary FVC*	0	0	0	0	0	0	0	0	4	0
TOTAL	5144	100	6021	100	6984	100	8106	100	9274	100

Access types	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
Wrist AVF	7798	68	8309	65	9491	62	10665	61	10985	58
BCF*	2856	25	3421	27	4403	29	5243	30	6016	32
Venous graft	22	0	37	0	19	0	32	0	49	0
Artificial graft	284	3	305	2	351	2	379	2	379	2
Permanent CVC	235	2	261	2	298	2	465	3	507	3
Temporary CVC*	298	3	424	3	579	4	770	4	803	4
Temporary FVC*	19	0	25	0	59	0	46	0	71	0
TOTAL	11512	100	12782	100	15200	100	17600	100	18810	100

\*CVC = central venous catheter, FVC = femoral venous catheter,

BCF = brachiocephalic fistula

No increase in difficulties was reported with vascular access since 2008.

**Table 11.1.2:** Difficulties report with Vascular Access, 2001-2010

Access difficulty	2001		2002		2003		2004		2005	
	n	%	n	%	n	%	n	%	n	%
Difficulty with needle placement	217	5	215	4	217	3	255	3	319	4
Difficulty in obtaining desired blood flow rate	239	5	235	4	243	4	301	4	354	4
Other difficulties	39	1	57	1	60	1	67	1	58	1
No difficulties	4276	90	5073	91	5970	92	6957	92	8339	92
TOTAL	4771	100	5580	100	6490	100	7580	100	9070	100

Access difficulty	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
Difficulty with needle placement	394	4	478	4	417	3	522	3	550	3
Difficulty in obtaining desired blood flow rate	356	3	368	3	420	3	473	3	427	2
Other difficulties	45	0	57	1	81	1	101	1	78	0
No difficulties	10592	93	11577	93	14076	94	16483	94	17828	94
TOTAL	11387	100	12480	100	14994	100	17579	100	18883	100

Complication rates for vascular access have reduced over the years from 17% in 2001 to 8% in 2010.

**Table 11.1.3:** Complications reported with Vascular Access, 2001-2010

Complication	2001		2002		2003		2004		2005	
	n	%	n	%	n	%	n	%	n	%
Thrombosis	209	4	202	4	220	3	284	4	289	3
Bleed	62	1	66	1	54	1	67	1	73	1
Aneurysmal dilatation	212	4	211	4	199	3	193	2	179	2
Swollen limb	67	1	56	1	55	1	77	1	84	1
Access related infection, local/systemic	49	1	52	1	43	1	70	1	63	1
Distal limb ischaemia	22	0	17	0	13	0	37	1	35	0
Venous outflow obstruction	123	2	101	2	119	2	151	2	170	2
Carpal tunnel	41	1	44	1	63	1	49	1	55	1
Others	74	2	118	2	118	2	133	2	109	1
No complications	4204	83	4988	85	5963	87	6896	87	8113	89
TOTAL	5063	100	5855	100	6847	100	7957	100	9170	100

Complication	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
Thrombosis	317	3	405	3	436	3	481	3	460	2
Bleed	69	1	58	1	76	1	72	0	78	0
Aneurysmal dilatation	246	2	385	3	396	3	452	3	319	2
Swollen limb	89	1	101	1	98	1	162	1	150	1
Access related infection, local/systemic	78	1	97	1	92	1	133	1	123	1
Distal limb ischaemia	30	0	27	0	31	0	25	0	33	0
Venous outflow obstruction	202	2	196	2	250	2	299	2	234	1
Carpal tunnel	48	0	46	0	48	0	48	0	44	0
Others	116	1	152	1	165	1	119	1	122	1
No complications	10154	90	11052	88	13517	90	15867	90	17356	92
TOTAL	11349	100	12519	100	15109	100	17658	100	18919	100



## SECTION 11.2: HD PRESCRIPTION

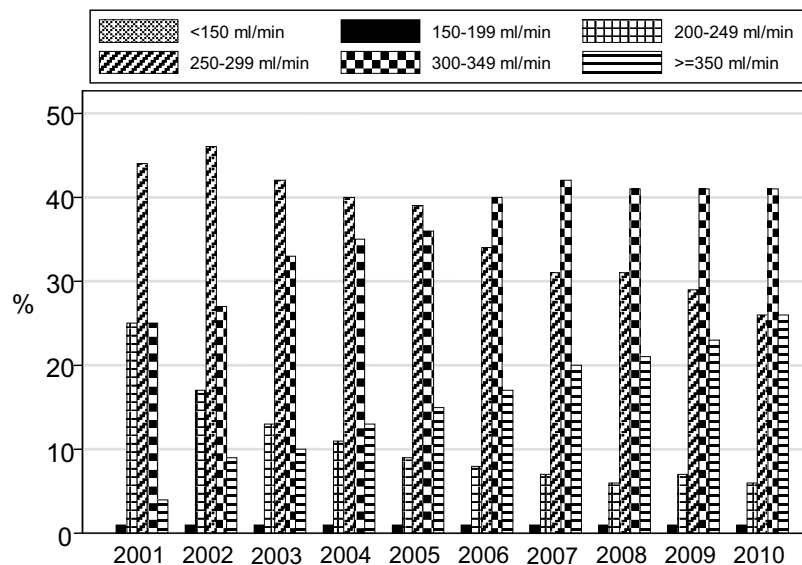
There is an increase in proportion of patients with blood flow rate above 350mls from year 2001 at 4% to 26% in 2010. Percentage of patients with blood flow rate of 300-349mls/min remained the same at 41%. There were 16 patients with blood flow rate of less than 150mls/min.

**Table 11.2.1:** Blood Flow Rates in HD centers, 2001-2010

Blood flow rates (ml/min)	2001		2002		2003		2004		2005	
	n	%	n	%	n	%	n	%	n	%
<150	7	0	9	0	4	0	11	0	7	0
150-199	69	1	69	1	84	1	86	1	94	1
200-249	1233	25	973	17	882	13	879	11	814	9
250-299	2229	44	2692	46	2865	42	3112	40	3523	39
300-349	1276	25	1590	27	2241	33	2711	35	3226	36
>=350	216	4	505	9	690	10	1020	13	1328	15
TOTAL	5030	100	5838	100	6766	100	7819	100	8992	100

Blood flow rates (ml/min)	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
<150	5	0	10	0	10	0	14	0	16	0
150-199	103	1	87	1	120	1	126	1	111	1
200-249	923	8	929	7	928	6	1179	7	1174	6
250-299	3818	34	3821	31	4638	31	5050	29	4944	27
300-349	4529	40	5214	42	6127	41	7093	41	7610	41
>=350	1920	17	2451	20	3094	21	3977	23	4807	26
TOTAL	11298	100	12512	100	14917	100	17439	100	18662	100

**Figure 11.2.1:** Blood Flow Rates in HD centers, 2001-2010



The majority of patients (98%) were on 3 dialysis sessions per week. Three hundred sixteen patients were dialysed less than 3 times per week.

**Table 11.2.2:** Number of HD Sessions per week, 2001-2010

HD sessions per week	2001		2002		2003		2004		2005	
	n	%	n	%	n	%	n	%	n	%
1	8	0	10	0	15	0	11	0	7	0
2	337	7	369	6	343	5	281	4	265	3
3	4761	92	5603	93	6585	95	7751	96	9011	97
4	50	1	18	0	9	0	30	0	31	0
TOTAL	5156	100	6000	100	6952	100	8073	100	9314	100

HD sessions per week	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
1	25	0	14	0	5	0	6	0	9	0
2	273	2	256	2	259	2	269	2	307	2
3	11326	97	12602	98	15054	98	17575	98	18828	98
4	34	0	31	0	61	0	88	1	47	0
TOTAL	11658	100	12903	100	15379	100	17938	100	19191	100

Majority of patients (99%) were on 4 hours HD sessions. A small number of patients (122) were dialysed more than 4 hours.

**Table 11.2.3:** Duration of HD, 2001-2010

Duration of HD per session (hours)	2001		2002		2003		2004		2005	
	n	%	n	%	n	%	n	%	n	%
<=3	8	0	18	0	14	0	25	0	31	0
3.5	12	0	15	0	3	0	11	0	9	0
4	4988	97	5854	98	6798	98	7885	98	9175	99
4.5	93	2	60	1	66	1	106	1	46	1
5	59	1	47	1	63	1	45	1	52	1
>5	0	0	0	0	0	0	3	0	0	0
TOTAL	5160	100	5994	100	6944	100	8075	100	9313	100

Duration of HD per session	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
<=3	28	0	37	0	54	0	66	0	60	0
3.5	6	0	11	0	10	0	25	0	36	0
4	11507	99	12792	99	15200	99	17733	99	18985	99
4.5	66	1	23	0	74	1	78	0	72	0
5	42	0	31	0	42	0	42	0	50	0
>5	1	0	1	0	0	0	1	0	0	0
TOTAL	11650	100	12895	100	15380	100	17945	100	19203	100

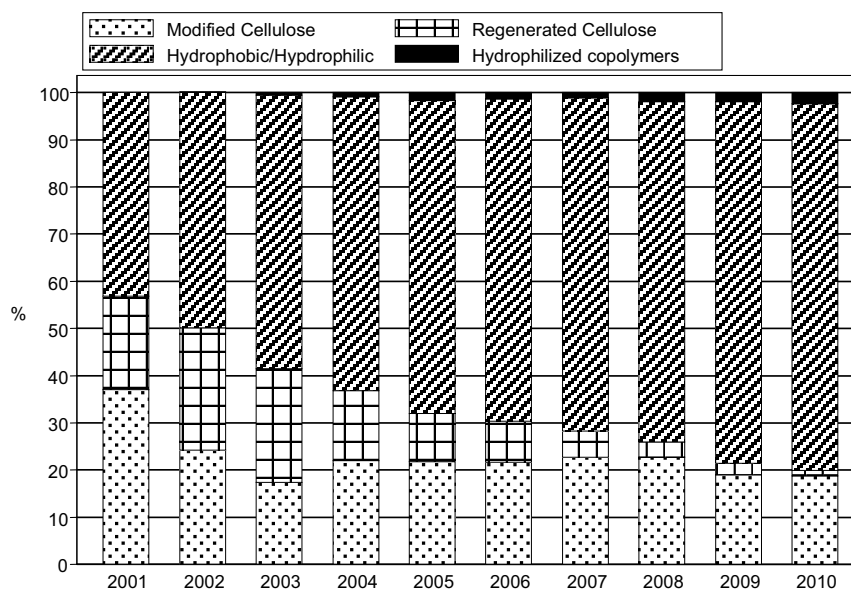
Eighty percent of the dialysers used were made from synthetic membrane (hydrophobic/ hydrophilic and hydrophilised co-polymer) in 2010.

**Table 11.2.4:** Dialyser membrane types in HD centres, 2001-2010

Dialyser membrane	2001		2002		2003		2004		2005	
	n	%	n	%	n	%	n	%	n	%
Modified Cellulose	1666	37	1377	24	1150	17	1719	22	1974	22
Regenerated Cellulose	890	20	1474	26	1599	24	1150	15	930	10
Hydrophobic/Hypdrophilic	1944	43	2828	50	3841	58	4846	62	6020	66
Hydrophilized copolymers	0	0	1	0	35	1	74	1	150	2
TOTAL	4500	100	5680	100	6625	100	7789	100	9074	100

Dialyser membrane	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
Modified Cellulose	2489	22	2890	23	3431	23	3241	19	3242	19
Regenerated Cellulose	997	9	699	6	486	3	418	3	202	1
Hydrophobic/Hypdrophilic	7860	68	8984	71	10886	72	13053	77	13410	78
Hydrophilized copolymers	161	1	137	1	286	2	335	2	409	2
TOTAL	11507	100	12710	100	15089	100	17047	100	17263	100

**Figure 11.2.4:** Dialyser membrane types in HD centres, 2001-2010



Re-use of dialysers is common practice whereby 90% re-used the dialyser. Nineteen percent of patients re-used more than 13 times. The practice of single use dialyser is growing over the years from 3% in 2001 to 10% in 2010.

**Table 11.2.5:** Dialyser Re-use Frequency in HD centres, 2001-2010

Dialyser Reuse Frequency	2001		2002		2003		2004		2005	
	n	%	n	%	n	%	n	%	n	%
1	152	3	197	4	251	4	319	5	196	5
2	15	0	41	1	19	0	42	1	1	0
3	232	5	316	6	349	6	194	3	81	2
4	416	9	337	7	339	6	192	3	85	2
5	357	8	318	6	267	5	192	3	137	3
6	1413	31	1216	24	915	16	806	13	555	13
7	85	2	124	2	71	1	89	1	44	1
8	793	17	866	17	852	15	809	13	477	11
9	132	3	59	1	87	2	50	1	46	1
10	400	9	538	11	880	15	1160	19	770	18
11	43	1	36	1	25	0	42	1	12	0
12	470	10	879	17	1511	26	1916	31	1353	31
≥ 13	84	2	175	3	280	5	458	7	565	13
TOTAL	4592	100	5102	100	5846	100	6269	100	4322	100

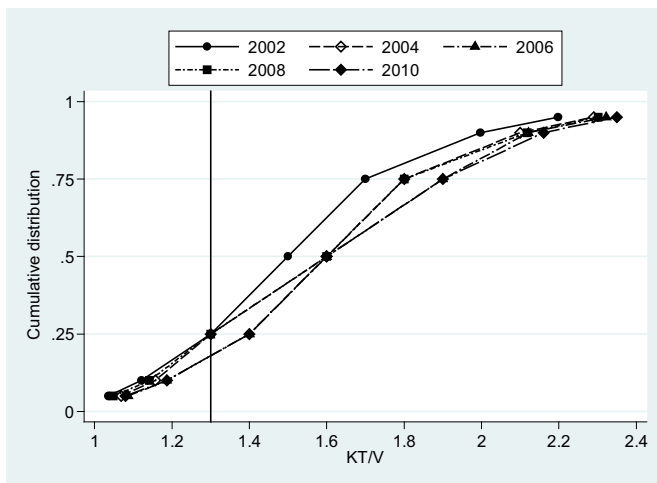
Dialyser Re-use Frequency	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
1	400	6	568	6	810	7	1175	8	1493	10
2	5	0	24	0	29	0	29	0	22	0
3	36	1	117	1	87	1	115	1	53	0
4	75	1	151	2	120	1	89	1	72	1
5	190	3	128	1	168	1	184	1	100	1
6	593	9	809	8	699	6	743	5	561	4
7	63	1	141	1	156	1	193	1	285	2
8	422	7	797	8	844	7	774	6	858	6
9	115	2	107	1	247	2	294	2	345	2
10	959	15	1530	15	2009	16	2651	19	2389	16
11	100	2	94	1	101	1	58	0	120	1
12	2243	35	4075	41	5266	43	5691	41	5858	39
≥ 13	1185	19	1440	14	1783	15	2010	14	2819	19
TOTAL	6386	100	9981	100	12319	100	14006	100	14975	100

The mean and median prescribed Kt/V is 1.6. The percentage of patients with prescribed Kt/V  $\geq 1.3$  in 2010 is 80 (Table & Figure 11.2.6(a)). The median and mean delivered Kt/V was 1.4 in 2010. The percentage of patients with a delivered Kt/V  $\geq 1.3$  was 62%. There was a small decline in the percentage of patients achieving delivered Kt/V  $\geq 1.3$  compared to last year.

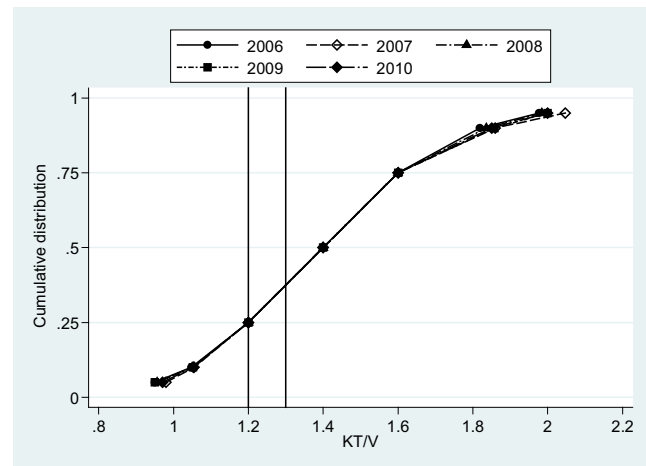
**Table 11.2.6(a):** Distribution of prescribed Kt/V, HD patients 2001-2010

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients $\geq 1.3$
2001	4908	1.5	0.4	1.5	1.3	1.7	73
2002	5496	1.5	0.4	1.5	1.3	1.7	73
2003	6525	1.6	0.4	1.6	1.3	1.8	79
2004	7457	1.6	0.4	1.6	1.4	1.8	81
2005	8749	1.6	0.4	1.6	1.4	1.9	81
2006	11092	1.6	0.4	1.6	1.3	1.8	77
2007	12354	1.6	0.4	1.6	1.3	1.8	78
2008	14752	1.6	0.4	1.6	1.3	1.8	79
2009	17253	1.6	0.4	1.6	1.4	1.9	82
2010	18478	1.6	0.4	1.6	1.4	1.9	80

**Figure 11.2.6(a):** Cumulative distribution of prescribed Kt/V, HD patients 2001-2010



**Figure 11.2.6 (b):** Cumulative distribution of delivered Kt/V, HD patients 2006-2010



**Table 11.2.6(b):** Distribution of delivered Kt/V, HD patients 2006-2010

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients $\geq 1.2$	% patients $\geq 1.3$	Variance*
2006	5555	1.4	1.3	1.4	1.2	1.6	76	59	0.2
2007	6360	1.5	0.6	1.4	1.2	1.6	78	62	0.2
2008	8529	1.4	0.3	1.4	1.2	1.6	78	61	0.2
2009	10468	1.5	0.7	1.4	1.2	1.6	81	64	0.2
2010	11609	1.4	0.4	1.4	1.2	1.6	79	62	0.2

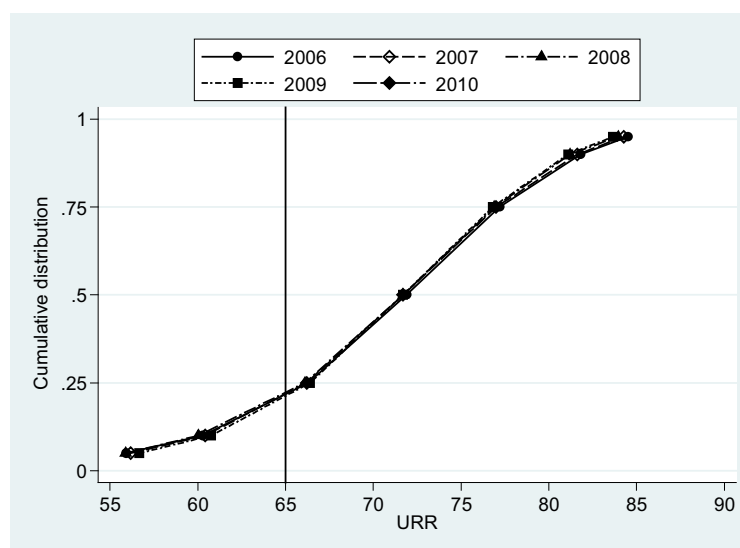
\*Variance = (prescribed Kt/V – delivered Kt/V)/ Prescribed Kt/V

The median URR remains the same at 71.7% over the last 3 years. The percentage of patients with URR  $\geq$  65% had risen to 80% in 2010 compared to 79% in 2009.

**Table 11.2.6(c):** Distribution of URR, HD patients 2006-2010

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients $\geq$ 65%
2006	8267	71.4	9.2	71.8	66.3	77.1	79
2007	9945	71.3	9.2	71.9	66.3	77.2	79
2008	12601	71.2	9	71.7	66.2	77	79
2009	14948	71	9	71.7	66.1	76.9	79
2010	16543	71.2	8.6	71.7	66.4	76.8	80

**Figure 11.2.6 (c):** Cumulative distribution of URR, HD patients 2006-2010



The median blood flow rates among centres had remained the same since 2005 at 300mls/min. There is still a wide variation in practices with regards to median blood flow rates among centres ranging, from 150mls/min to 400mls/min. One centre had a median blood flow rate of 150mls/min.

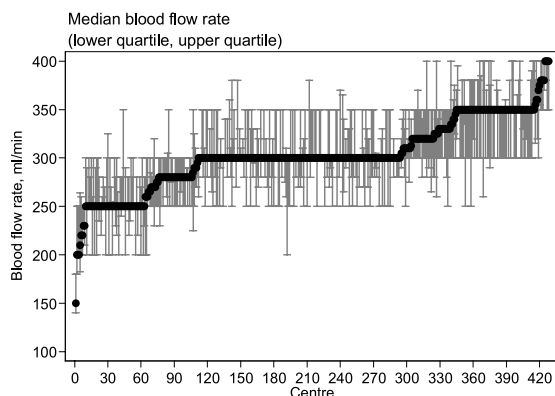
The current report had changed the target blood flow rate from 250 ml/min to > 300 ml/min & median blood flow rates of  $\geq 300$  ml/min. Fifty percent of centres had 75 % of their patients with blood flow rates of > 300 ml/min in 2010 compared to only 25.5% in 2001.

**Table 11.2.7: Variation HD prescription among HD centres, 2001-2010**

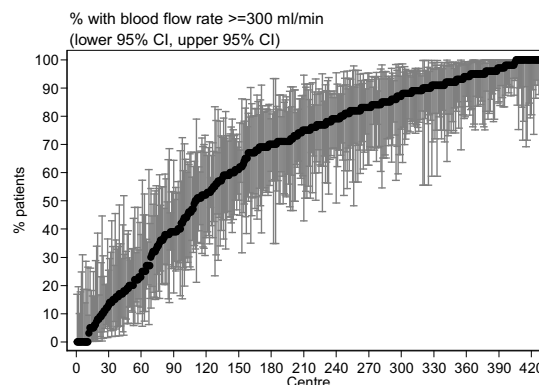
(a) Median blood flow rates in HD patients, HD centres

Year	Number of centers	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	116	200	220	250	252.5	300	300	350
2002	137	200	230	250	280	300	300	350
2003	155	200	240	250	280	300	325	350
2004	184	220	250	257.5	287.5	300	350	400
2005	228	200	250	260	300	300	350	400
2006	283	200	250	270	300	300	350	400
2007	302	200	250	280	300	300	350	400
2008	355	200	250	280	300	300	350	400
2009	404	180	250	280	300	320	350	400
2010	428	150	250	287.5	300	320	350	400

**Figure 11.2.7 (a):** Variation in median blood flow rates in HD patients among centres 2010



**Figure 11.2.7 (b):** Variation in Proportion of patients with blood flow rates  $\geq 300$  ml/min among HD centres 2010



**Table 11.2.7 (b)** Proportion of patients with blood flow rates > 300 ml/min, HD centres 2001-2010

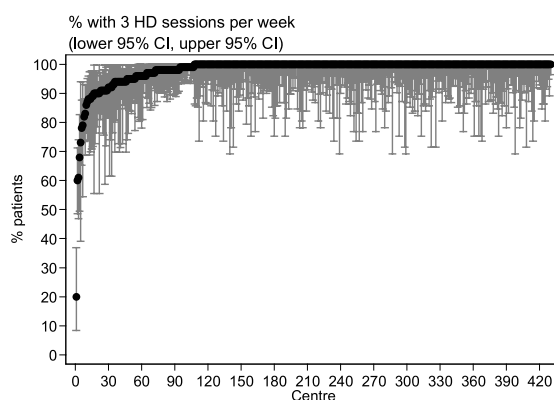
Year	Number of centers	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	116	0	0	8	25.5	51.5	81	100
2002	137	0	0	13	33	61	90	100
2003	155	0	0	21	45	69	91	100
2004	184	0	4	23.5	48.5	73	93	100
2005	228	0	0	28	53	77	94	100
2006	283	0	5	30	63	83	94	100
2007	302	0	7	37	68	84	96	100
2008	355	0	9	40	70	86	99	100
2009	404	0	11	42.5	72	88	99	100
2010	428	0	9	47	75	90	100	100

The majority of centres had 100% of their patients with 3 HD sessions/ week. There was one centre with 50% of their patients on less than 3 HD session/ week compared to last year.

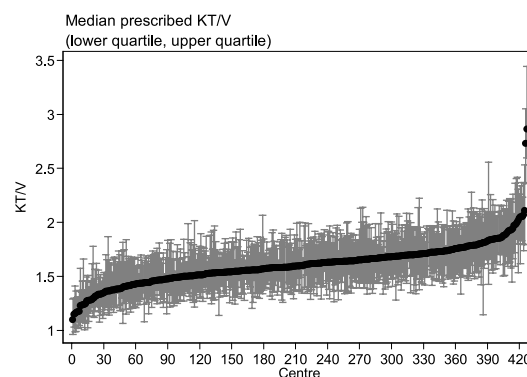
**Table 11.2.7 (c):** Proportion of patients with 3 HD sessions per week, HD centres 2001-2010

Year	Number of centers	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	118	23	50	92	100	100	100	100
2002	137	28	48	94	99	100	100	100
2003	160	36	55	97	100	100	100	100
2004	188	37	70	98	100	100	100	100
2005	231	40	75	99	100	100	100	100
2006	287	52	83	98	100	100	100	100
2007	309	51	87	98	100	100	100	100
2008	359	51	89	98	100	100	100	100
2009	404	18	88	100	100	100	100	100
2010	430	20	90	100	100	100	100	100

**Figure 11.2.7 (c):** Variation in proportion of patients with 3 HD sessions per week among HD centres 2010



**Figure 11.2.7 (d):** Variation in median prescribed Kt/V in HD patients among HD centres 2010



The median prescribed Kt/V was 1.6. In 2010, half the centres had 83% of their patients with a prescribed Kt/V  $\geq 1.3$ . However there is still a wide variation in proportion of patients with Kt/V  $\geq 1.3$  among the centres. One centre was noted to have less than 20% of their patients with a prescribed Kt/V  $\geq 1.3$ .

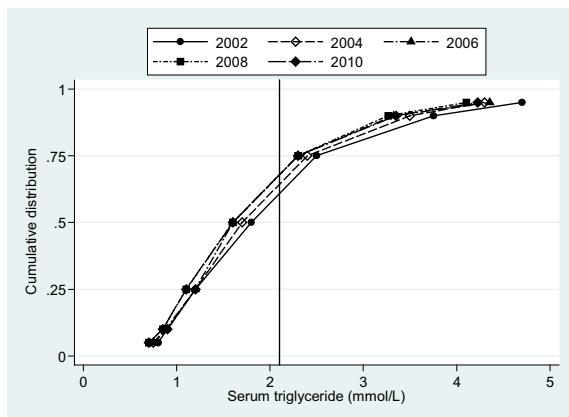
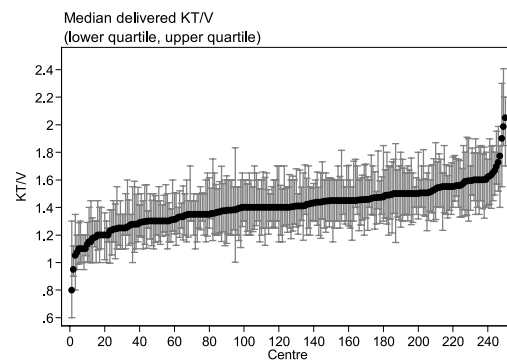
**Table 11.2.7 (d):** Median prescribed Kt/V in HD patients, HD centres 2001-2010

Year	Number of centers	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	114	1.2	1.3	1.4	1.5	1.6	1.7	1.9
2002	132	1.2	1.3	1.4	1.5	1.6	1.7	1.8
2003	150	1.1	1.3	1.4	1.6	1.7	1.9	2
2004	181	1.2	1.4	1.5	1.6	1.7	1.8	2.2
2005	224	1.2	1.3	1.5	1.6	1.7	1.8	2
2006	281	1	1.3	1.4	1.6	1.7	1.8	2.1
2007	302	1.1	1.3	1.4	1.6	1.7	1.8	2.1
2008	353	1.1	1.3	1.4	1.6	1.7	1.9	2.1
2009	400	1.1	1.3	1.5	1.6	1.7	1.9	2.2
2010	427	1.1	1.3	1.5	1.6	1.7	1.9	2.9



**Table 11.2.7 (e):** Proportion of patients with prescribed Kt/V  $\geq 1.3$ , 2001-2010

Year	Number of centers	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	114	33	42	67	75	83	93	100
2002	132	26	43	65	74.5	83	92	98
2003	150	30	48	71	81	89	96	100
2004	181	28	58	74	83	91	98	100
2005	224	32	56	73	82	90	98	100
2006	281	0	46	67	79	87	96	100
2007	302	21	50	67	80	89	96	100
2008	353	14	47	69	83	89	98	100
2009	400	26	53	74	83	91	97	100
2010	427	18	54	73	83	91	100	100

**Figure 11.2.7 (e):** Variation in proportion of patients with prescribed Kt/V  $\geq 1.3$  among HD centres 2010**Figure 11.2.7 (f):** Variation in median delivered Kt/V in HD patients among HD centres 2010

The median delivered Kt/V was 1.4. The variation of median delivered Kt/V ranges from 0.8 to 2. The number of centres reporting delivered Kt/V has escalated from 142 in 2006 to 250 in 2010.

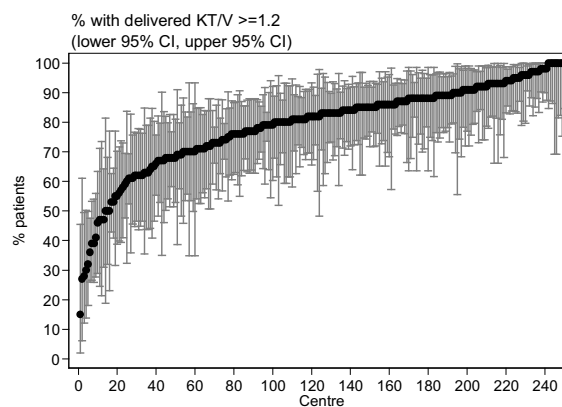
Fifty percent of centres had 83% of their patients with a delivered Kt/V  $\geq 1.2$ . There was one centre with  $< 20\%$  of their patients with a delivered Kt/V  $\geq 1.2$

**Table 11.2.7 (f):** Median delivered Kt/V in HD patients, HD centres 2006-2010

Year	Number of centers	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2006	142	1	1.2	1.3	1.4	1.5	1.6	1.7
2007	157	1.1	1.2	1.3	1.4	1.5	1.7	1.8
2008	199	1	1.2	1.3	1.4	1.5	1.7	1.8
2009	239	1	1.2	1.3	1.4	1.5	1.6	2
2010	250	0.8	1.2	1.3	1.4	1.5	1.6	2

**Table 11.2.7 (g):** Proportion of patients with delivered Kt/V  $\geq 1.2$ , HD centres 2006-2010

Year	Number of centers	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2006	142	0	43	65	76	86	94	100
2007	157	34	46	70	79	89	97	100
2008	199	21	49	68	81	89	100	100
2009	239	16	51	74	83	89	97	100
2010	250	15	47	71	83	89	98	100

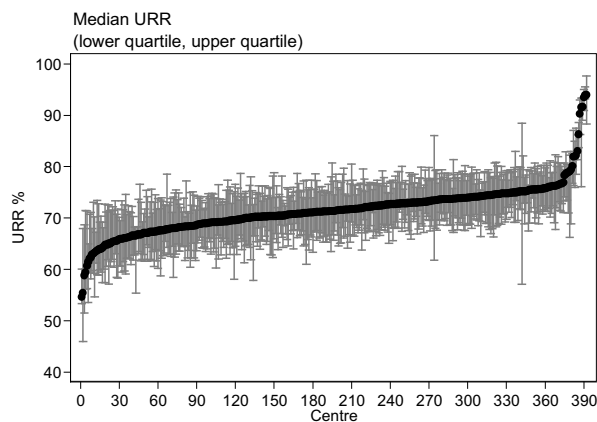
**Figure 11.2.7 (g):** Variation in proportion of patients with delivered Kt/V  $\geq 1.2$ , HD centres 2010

The median URR for 2010 is 71.4%. The variation of URR ranges from 22% to 100%. In 2010, 50% of centres had 82% of their patients with URR  $\geq$ 65%, an increased from 2009. There were 2 centres with less than 20% of their patients with URR  $\geq$  65%.

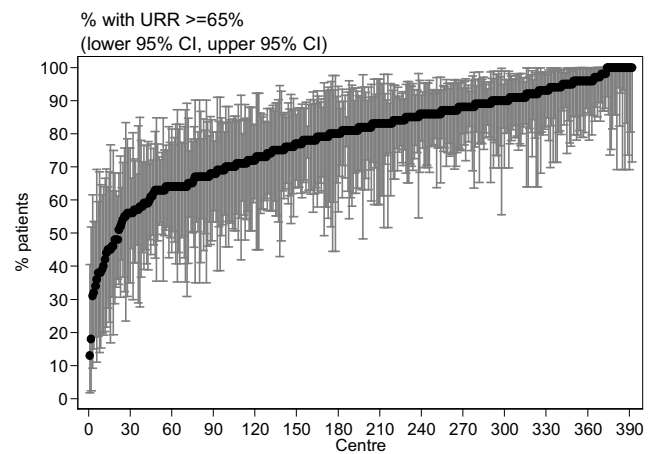
**Table 11.2.7 (h):** Median URR among HD patients, HD centres 2006-2010

Year	Number of centers	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2006	214	55.4	64.2	68.9	71.5	74.3	78.2	94.4
2007	245	56.1	65.3	69.6	71.8	74.8	78	95.5
2008	310	40.4	63.5	68.5	71.7	74.4	77.9	93.6
2009	350	60	64.4	68.7	71.8	74.1	77	93.3
2010	392	54.6	64.8	69	71.4	73.8	76.7	94

**Figure 11.2.7 (h):** Variation in median URR among HD patients, HD centres 2010



**Figure 11.2.7 (i):** Variation in proportion of patients with URR  $\geq$  65% among HD centres 2010



**Table 11.2.7 (i):** Proportion of HD patients with URR  $\geq$  65%, HD centres 2006-2010

Year	Number of centers	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2006	214	0	50	69	79.5	88	97	100
2007	245	15	51	71	82	89	97	100
2008	310	0	43	69	82.5	90	98	100
2009	350	22	45	69	81	89	97	100
2010	392	13	48	69.5	82	90	98	100

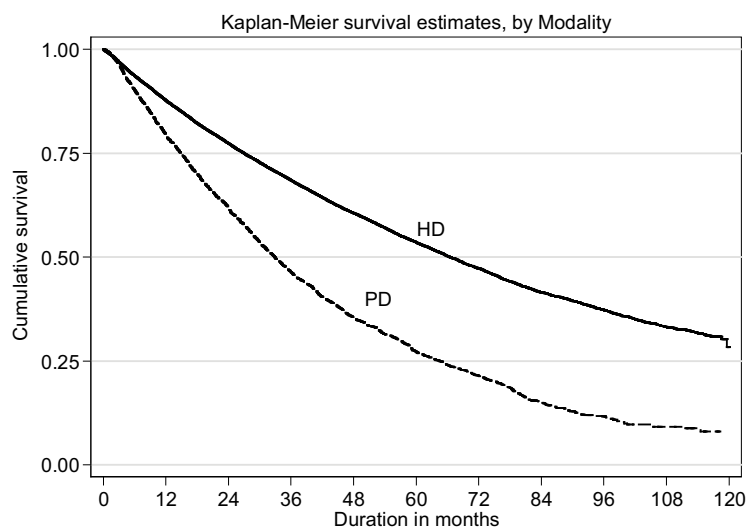
### SECTION 11.3: TECHNIQUE SURVIVAL ON DIALYSIS

The unadjusted HD technique survival at 1, 5, and 9 years was 88%, 53% and 33% respectively. The PD unadjusted technique survival was 79% at 1 year, 27% at 5 years and 9 % at 9 years.

**Table 11.3.1:** Unadjusted technique survival by Dialysis modality, 2001-2010

Dialysis modality Interval (month)	PD			HD			All Dialysis		
	n	% Survival	SE	n	% Survival	SE	n	% Survival	SE
0	4800	100	-	31940	100	-	36740	100	-
6	4041	90	0	28012	94	0	32053	93	0
12	3270	79	1	23915	88	0	27185	87	0
24	2107	62	1	17500	77	0	19607	75	0
36	1307	46	1	12701	68	0	14008	66	0
48	786	35	1	8913	61	0	9699	57	0
60	474	27	1	6048	53	0	6522	50	0
72	301	21	1	4022	47	0	4322	44	0
84	153	15	1	2456	41	0	2608	38	0
96	69	12	1	1394	37	0	1462	34	0
108	28	9	1	568	33	1	595	30	1
120	-	-	-	-	-	-	-	-	-

**Figure 11.3.1:** Unadjusted technique survival by Dialysis modality, 2001-2010



There was no apparent difference in the unadjusted technique survival by years of starting dialysis for the years 2001 to 2010.

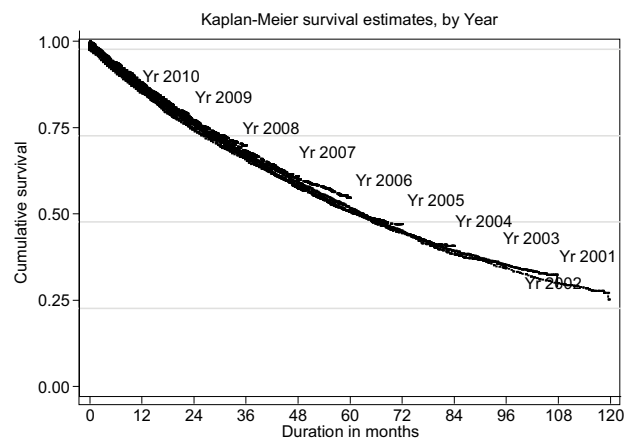
**Table 11.3.2:** Unadjusted technique survival by year of entry, 2001-2010

Year Interval (month)	2001			2002			2003		
	n	% Survival	SE	n	% Survival	SE	n	% Survival	SE
0	1901	100	-	2149	100	-	2339	100	-
6	1771	93	1	2015	94	1	2170	94	0
12	1625	87	1	1883	89	1	2004	88	1
24	1404	77	1	1613	78	1	1755	78	1
36	1232	68	1	1427	70	1	1534	69	1
48	1086	61	1	1256	61	1	1346	61	1
60	945	53	1	1099	54	1	1183	54	1
72	832	47	1	959	47	1	1031	47	1
84	736	41	1	838	41	1	882	40	1
96	646	37	1	748	37	1	-	-	-
108	568	32	1	-	-	-	-	-	-
120	-	-	-	-	-	-	-	-	-

Year Interval (month)	2004			2005			2006			2007		
	n	% Survival	SE	n.	% Survival	SE	n.	% Survival	SE	n	% Survival	SE
0	2746	100	-	2954	100	-	3412	100	-	3669	100	-
6	2570	94	0	2725	93	0	3131	93	0	3438	94	0
12	2373	88	1	2516	87	1	2908	87	1	3192	88	1
24	2071	78	1	2176	76	1	2550	77	1	2796	78	1
36	1791	68	1	1917	67	1	2240	68	1	2459	69	1
48	1567	60	1	1661	59	1	2001	61	1	-	-	-
60	1366	52	1	1457	52	1	-	-	-	-	-	-
72	1202	46	1	-	-	-	-	-	-	-	-	-
84	-	-	-	-	-	-	-	-	-	-	-	-

Year Interval (month)	2008			2009			2010		
	n	% Survival	SE	n	% Survival	SE	n	% Survival	SE
0	4149	100	-	4391	100	-	4230	100	-
6	3869	94	0	4092	94	0	2243	93	0
12	3610	88	1	3806	88	0	-	-	-
24	3141	77	1	-	-	-	-	-	-
36	-	-	-	-	-	-	-	-	-

**Figure 11.3.2:** Unadjusted technique survival by year of entry, 2001-2010



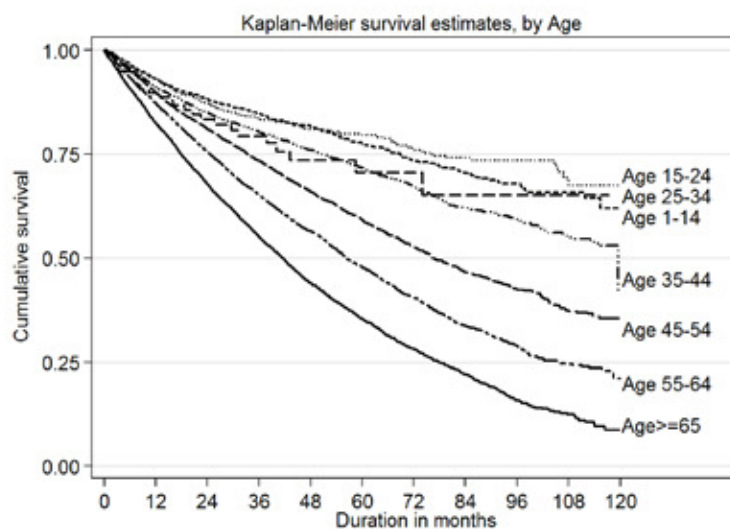
The unadjusted technique survival was better in the younger age groups than the older age group. At 9 years unadjusted technique survival in the age group of <14, 15-24, 25-34, 35-44, 44-54, 55-64 and  $\geq 65$  years old was 65%, 69%, 66%, 55 %, 37%, 24% and 12% respectively.

**Table 11.3.3:** Unadjusted technique survival by age, 2001-2010

Age group (year) Interval (month)	$\leq 14$			15-24			25-34			35-44		
	n	% Survival	SE	n	% Survival	SE	n	% Survival	SE	n	% Survival	SE
0	121	100	-	1013	100	-	2111	100	-	3754	100	-
6	110	95	2	915	96	1	1888	96	0	3346	95	0
12	96	90	3	812	93	1	1643	93	1	2912	91	0
24	74	83	4	619	87	1	1283	88	1	2274	85	1
36	50	79	4	500	83	1	1008	85	1	1749	80	1
48	33	73	5	383	81	1	779	81	1	1367	76	1
60	25	71	6	291	80	2	576	77	1	1006	72	1
72	19	71	6	216	76	2	430	73	1	742	67	1
84	10	65	7	144	74	2	297	70	2	474	62	1
96	7	65	7	90	74	2	179	68	2	306	59	1
108	3	65	7	41	69	3	67	66	2	138	55	2
120	-	-	-	-	-	-	-	-	-	-	-	-

Age group (year) Interval (month)	45-54			55-64			$\geq 65$		
	n	% Survival	SE	n	% Survival	SE	n	% Survival	SE
0	7965	100	-	9270	100	-	7706	100	-
6	7108	95	0	8089	93	0	6559	91	0
12	6114	90	0	6884	87	0	5456	82	0
24	4614	81	0	4942	76	0	3695	68	1
36	3436	73	1	3510	65	1	2449	55	1
48	2466	66	1	2393	56	1	1524	44	1
60	1683	59	1	1553	48	1	916	35	1
72	1118	53	1	961	40	1	545	28	1
84	704	47	1	545	34	1	289	22	1
96	416	42	1	276	29	1	122	16	1
108	175	37	1	106	24	1	42	12	1
120	-	-	-	-	-	-	-	-	-

**Figure 11.3.3:** Unadjusted technique survival by age, 2001-2010

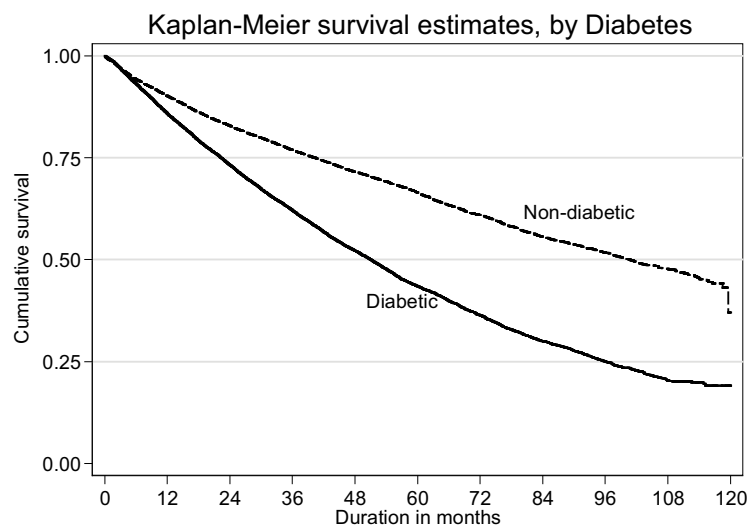


Unadjusted technique survival in non-diabetics at 1, 5, and 9 years was 90%, 66% and 48% respectively. Unadjusted technique survival for diabetics was worse than non-diabetics; 86% at 1 year, 43% at 5 years and only 20% at 9 years.

**Table 11.3.4:** Unadjusted technique survival by Diabetes status, 2001-2010

Diabetes status Interval (month)	Non-Diabetic			Diabetic		
	n	% Survival	SE	n	% Survival	SE
0	13763	100	-	18177	100	-
6	12108	94	0	15904	93	0
12	10523	90	0	13392	86	0
24	8090	83	0	9410	73	0
36	6219	77	0	6482	62	0
48	4640	72	0	4273	52	0
60	3411	66	1	2637	43	1
72	2426	61	1	1596	36	1
84	1573	56	1	886	30	1
96	952	52	1	442	25	1
108	420	48	1	148	20	1
120	-	-	-	-	-	-

**Figure 11.3.4:** Unadjusted technique survival by Diabetes status, 2001-2010



CHAPTER 12

**PERITONEAL DIALYSIS  
PRACTICES**

Sunita Bavanandan  
Lily Mushahar  
Anita Bhajan Manocha



**SECTION 12.1: MODALITIES AND PRESCRIPTION OF PD (Tables 12.1.1 -12.1.4)**

In 2010, there were a total of 2360 patients on PD in Malaysia. While the overall number of PD patients has been increasing over the last decade, annual PD growth rates which were initially 15-16% in 2006/2007, 2007/2008 have tapered down to 6-6.7% in 2008/2009 and 2009/2010. In 2010, 87.5% of PD patients were on CAPD and 12.5 % on APD. APD penetration is increasing, albeit at a slow rate. DAPD is prescribed in up to 3.9% of patients to minimize fluid absorption during overnight dwell. This PD regime is utilised mainly as an alternative to Icodextrin use or APD which would be more costly.

Most patients are on the Baxter disconnect system (90.7%) and the majority (84.5%) do 4 exchanges per day. Nine percent of patients require 5 exchanges per day but this figure may not truly reflect the dwell volumes required for PD adequacy as some patients may be converted to haemodialysis rather than increase the number of daily exchanges. Most patients (86.3%) used a fill volume of 2 litres but up to 10.5% were using larger fill volumes

**Table 12.1.1: Chronic Peritoneal Dialysis Regimes, 2001-2010**

PD regime	2001		2002		2003		2004		2005	
	n	%	n	%	n	%	n	%	n	%
Standard CAPD	762	97.6	861	97	1192	96.8	1266	96.1	1303	93.2
DAPD	17	2.2	24	2.7	34	2.8	39	3	45	3.2
Automated PD/ CCPD	2	0.3	3	0.3	5	0.4	12	0.9	50	3.6
TOTAL	781	100	888	100	1231	100	1317	100	1398	100

PD regime	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
Standard CAPD	1397	90	1547	85.7	1717	82.4	1847	83.5	1973	83.6
DAPD	67	4.3	115	6.4	121	5.8	119	5.4	91	3.9
Automated PD/ CCPD	88	5.7	144	8	245	11.8	246	11.1	296	12.5
TOTAL	1552	100	1806	100	2083	100	2212	100	2360	100

**Table 12.1.2: CAPD Connectology, 2001-2010**

CAPD Connectology	2001		2002		2003		2004		2005	
	n	%	n	%	n	%	n	%	n	%
Baxter disconnect	439	99.8	726	98.5	1048	87	1147	88.8	1286	92.1
Fresenius disconnect	0	0	11	1.5	154	12.8	145	11.2	111	7.9
Others	1	0.2	0	0	3	0.2	0	0	0	0
TOTAL	440	100	737	100	1205	100	1292	100	1397	100

CAPD Connectology	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
Baxter disconnect	1425	92	1675	93.5	1955	93.9	2013	92.1	2126	90.7
Fresenius disconnect	119	7.7	116	6.5	124	6	173	7.9	218	9.3
Others	5	0.3	0	0	4	0.2	0	0	1	0
TOTAL	1549	100	1791	100	2083	100	2186	100	2345	100

**Table 12.1.3:** PD Number of Exchanges per day, 2001-2010

Number of Exchanges/ day	2001		2002		2003		2004		2005	
	n	%	n	%	n	%	n	%	n	%
2	1	0.1	0	0	4	0.3	6	0.5	3	0.2
3	5	0.6	11	1.3	14	1.2	12	0.9	25	1.8
4	735	95.2	834	95.5	1136	95.8	1225	94.6	1280	94.4
5	31	4	28	3.2	32	2.7	52	4	48	3.5
TOTAL	772	100	873	100	1186	100	1295	100	1356	100

Number of Exchanges/ day	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
2	4	0.3	2	0.1	3	0.1	3	0.1	9	0.4
3	55	3.7	40	2.3	54	2.7	87	4.1	134	6.1
4	1359	91	1566	90.5	1728	86.4	1791	84.7	1865	84.5
5	76	5.1	123	7.1	216	10.8	233	11	198	9
TOTAL	1494	100	1731	100	2001	100	2114	100	2206	100

**Table 12.1.4:** PD Volume per Exchange, 2001-2010

Volume per Exchange (L)	2001		2002		2003		2004		2005	
	n	%	n	%	n	%	n	%	n	%
<1.5	32	4.3	37	4.4	41	3.5	42	3.3	55	4.1
1.5-1.9	0	0	0	0	0	0	0	0	0	0
2.0	711	94.5	793	94	1088	93.8	1154	91.9	1195	89
>2.0	9	1.2	14	1.7	31	2.7	60	4.8	92	6.9
TOTAL	752	100	844	100	1160	100	1256	100	1342	100

Volume per Exchange (L)	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
<1.5	50	3.3	46	2.7	56	2.8	60	2.9	68	3.3
1.5-1.9	0	0	0	0	0	0	0	0	0	0
2.0	1315	87.7	1508	87.6	1756	87.8	1805	87.9	1791	86.3
>2.0	135	9	167	9.7	189	9.4	189	9.2	217	10.5
TOTAL	1500	100	1721	100	2001	100	2054	100	2076	100

### SECTION 12.2: ACHIEVEMENT OF SOLUTE CLEARANCE AND PERITONEAL TRANSPORT

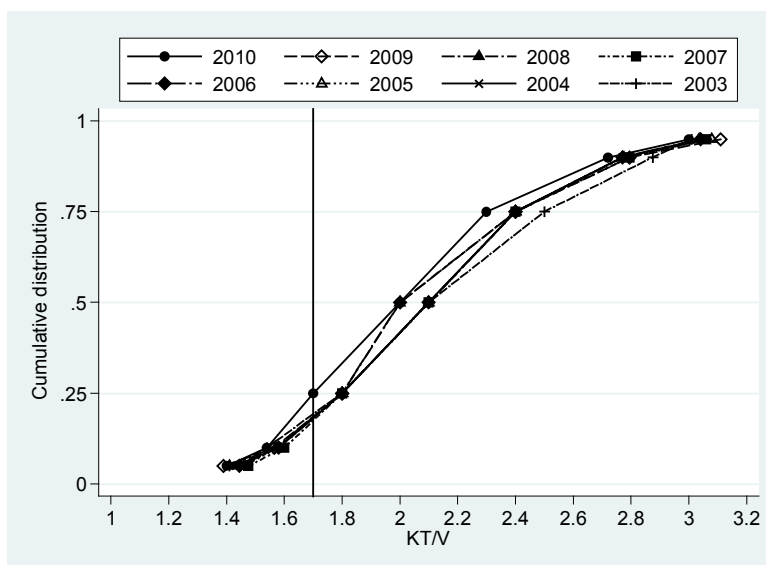
Seventy nine percent of patients achieved the K/DOQI target recommendation of Kt/V of  $\geq 1.7$  per week and the median delivered weekly Kt/V was 2.0. Comparison between PD centres according to the percentage of patients in each centre achieving this target Kt/V has shown a 1.5-fold variation between the highest- and lowest-performing centres (90% vs. 59%). Half of the centres were able to have up to 79% of their patients achieving this target (Tables and Figures 12.2.1 and 12.2.2).

Among incident PD patients high average transport status was commonest (37 %) followed by low average transport status (24%). Over time a proportion of patients will develop changes in their peritoneal membrane characteristics although contrary to expectation, there seems to be a reduction in the number of high/high average transporters when comparing incident with prevalent patients (Tables 12.2.3 and 12.2.4). This may be due to early transfer of such patients to HD . There is no apparent association between co-morbidities such as cardiovascular disease and diabetes with PET status.

**Table 12.2.1:** Distribution of delivered Kt/V, PD patients 2003-2010

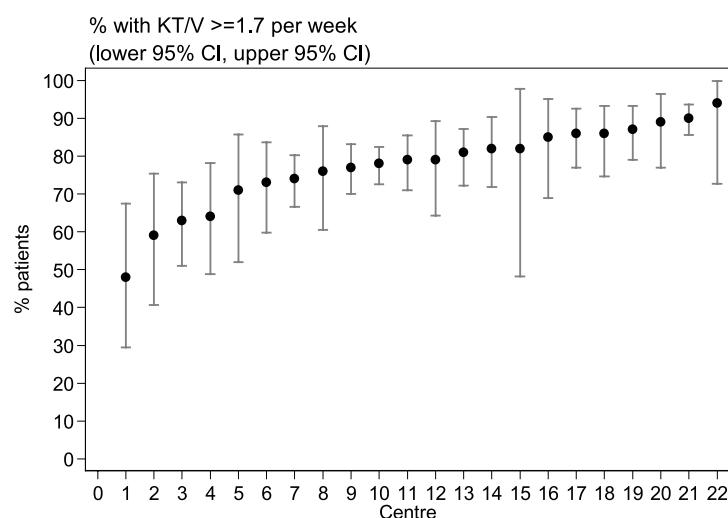
Year	Number of Patients	Mean	SD	Median	LQ	UQ	% patients $\geq 1.7$ per week
2003	763	2.1	0.5	2.1	1.8	2.5	83
2004	1038	2.1	0.5	2.1	1.8	2.4	85
2005	1092	2.1	0.5	2.1	1.8	2.4	83
2006	1266	2.1	0.5	2.1	1.8	2.4	84
2007	1412	2.1	0.5	2.1	1.8	2.4	83
2008	1679	2.1	0.5	2	1.8	2.4	82
2009	1837	2.1	0.5	2	1.8	2.4	81
2010	1913	2.1	0.5	2	1.7	2.3	79

**Figure 12.2.1:** Cumulative distribution of delivered Kt/V, PD patients 2003-2010



**Table 12.2.2:** Variation in proportion of patients with Kt/V  $\geq 1.7$  per week among PD centres, 2003-2010

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2003	14	0	0	75	82.5	88	91	91
2004	17	75	75	79	85	88	100	100
2005	18	56	56	75	85	89	96	96
2006	20	66	66	78	82.5	91.5	100	100
2007	21	25	69	78	85	89	93	93
2008	20	33	50.5	76.5	80	89	93.5	96
2009	21	48	63	76	83	89	97	100
2010	22	48	59	73	79	86	90	94

**Figure 12.2.2:** Variation in proportion of patients with Kt/V  $\geq 1.7$  per week among PD centres 2010**Table 12.2.3:** Peritoneal transport status by PET D/P creatinine at 4 hours, new PD patients 2003-2010

Year	2003		2004		2005		2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Low	10	3	39	9	44	13	23	8	19	10	19	14	10	10	15	22
Low average	174	44	180	42	130	39	106	38	65	34	43	31	37	38	16	24
High average	171	43	168	39	118	35	106	38	78	41	50	36	33	34	25	37
High	39	10	41	10	42	13	41	15	28	15	25	18	18	18	11	16
TOTAL	394	100	428	100	334	100	276	100	190	100	137	100	98	100	67	100

**Table 12.2.4:** Peritoneal transport status by PET D/P creatinine at 4 hours, prevalent PD patients 2003-2010

Year	2003		2004		2005		2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Low	10	6	67	15	69	12	105	12	106	10	151	13	196	14	195	14
Low average	85	51	187	41	246	41	359	42	429	42	500	42	557	39	566	39
High average	62	37	176	38	223	37	315	37	392	38	415	35	478	34	501	34
High	11	7	29	6	62	10	75	9	95	9	114	10	186	13	181	13
TOTAL	168	100	459	100	600	100	854	100	1022	100	1180	100	1417	100	1443	100

**Table 12.2.5:** Association among PET and comorbidity, 2003-2010

Co morbidity	Low		Low Average		High Average		High	
	n	%	n	%	n	%	n	%
No CVD	757	13.2	2374	41.4	2031	35.4	576	10
CVD	142	10.1	555	39.5	531	37.8	177	12.6
No DM	567	13.8	1710	41.7	1427	34.8	396	9.7
DM	332	10.9	1219	40.1	1135	37.3	357	11.7

### SECTION 12.3: TECHNIQUE SURVIVAL ON PD

Technique survival (not censored for death and transplant) revealed poorer survival in PD compared to HD modality. The Kaplan-Meier cumulative PD survival curves diverge as early as 6 months. One-, three- and five-year PD technique survival was 79%, 46% and 27% compared to 88%, 68% and 53% in HD respectively. Median PD technique survival time was 34 months (Table and Figure 12.3.1). The PD technique survival was analyzed for two different eras (2001-2004 versus 2005-2010) (Table and Figure 12.3.2) and it showed there has not been any significant improvement in technique survival over time.

The trend has been maintained with better technique survival seen in the younger groups (age < 25 years), while the elderly (age > 65 years) consistently had the worst technique survival (Table and Figure 12.3.3). Gender did not show any influence in technique survival during early period of treatment (<36 months). However, female gender appears to have better technique survival after 36 months (Table and Figure 12.3.4). Diabetics have poorer technique survival compared to non-diabetics (Table and Figure 12.3.5).

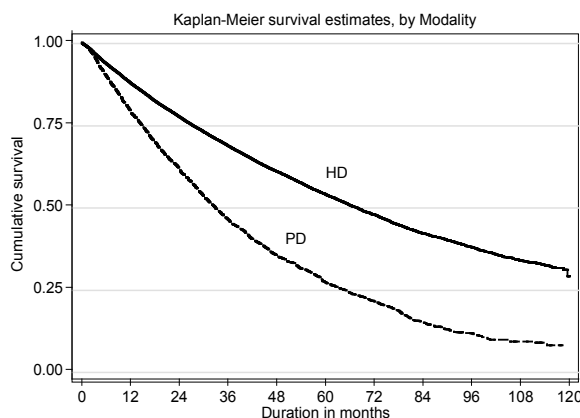
There was a clear association of technique survival with solute clearance. As expected, those with  $Kt/v \geq 2.0$  demonstrated the best technique survival compared to those with  $Kt/v \leq 1.7$  (Table and Figure 12.3.6).

Age above 25 years, diabetic status, male gender, presence of CVD, poor nutritional indices (low BMI, low serum albumin and low cholesterol), anaemia, hypercalcemia, hyperphosphatemia, poor BP control and assisted PD were associated with increased risk of drop-out from PD (Table 12.3.7). In year 2010, death remains the major factor for PD drop-out (65%), followed by peritonitis (15%) (Table 12.3.8).

**Table 12.3.1:** Unadjusted technique survival by Dialysis modality, 2001-2010

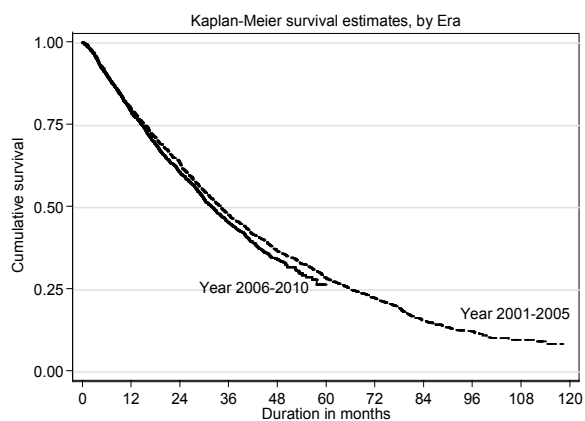
Dialysis Modality Interval (month)	PD			HD			All dialysis		
	n	% Survival	SE	n	% Survival	SE	n	% Survival	SE
0	4800	100	-	31900	100	-	36740	100	-
6	4041	90	0	28012	94	0	32053	93	0
12	3270	79	1	23915	88	0	27185	87	0
24	2107	62	1	17500	77	0	19607	75	0
36	1307	46	1	12701	68	0	14008	66	0
48	786	35	1	8913	61	0	9699	57	0
60	474	27	1	6048	53	0	6522	50	0
72	301	21	1	4022	47	0	4322	44	0
84	153	15	1	2456	41	0	2608	38	0
96	69	12	1	1394	37	0	1462	34	0
108	28	9	1	568	33	1	595	30	1
120	1	-	-	1	-	-	1	-	-

**Figure 12.3.1:** Unadjusted technique survival by Dialysis modality, 2001-2010



**Table 12.3.2:** Unadjusted technique survival by era 2001–2005 and 2006–2010

Era Interval (month)	2001 – 2005			2006 – 2010		
	n	% Survival	SE	n	% Survival	SE
0	1832	100	-	2968	100	-
6	1645	90	0.7	2399	90	0.56
12	1445	80	0.94	1825	79	0.8
24	1117	63	1.14	997	60	1.05
36	826	48	1.19	481	45	1.22
48	625	37	1.15	163	34	1.4
60	474	28	1.08	1	-	-
72	301	22	1.03	-	-	-
84	153	15	0.96	-	-	-
96	69	12	0.96	-	-	-
108	28	9	1.03	-	-	-
120	-	-	-	-	-	-

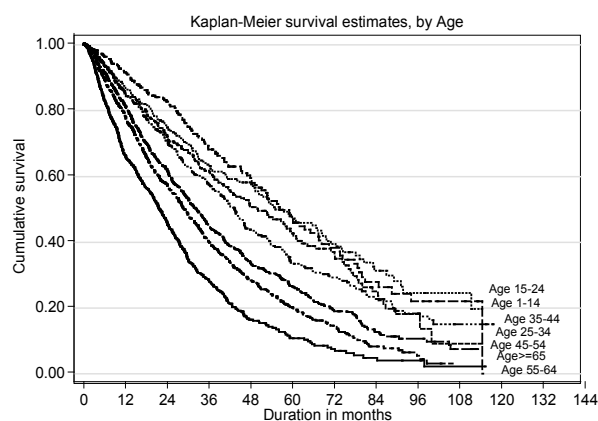
**Figure 12.3.2:** Unadjusted technique survival by era 2001–2005 and 2006–2010

**Table 12.3.3:** Unadjusted technique survival by age, 2001-2010

Age group (years) Interval (month)	<15			15-24			25-34			35-44		
	n	% Survival	SE	n	% Survival	SE	n	% Survival	SE	n	% Survival	SE
0	313	100	-	404	100	-	411	100	-	564	100	-
6	287	96	1	358	94	1	350	94	1	502	93	1
12	245	92	2	305	87	2	282	85	2	430	85	2
24	174	83	2	211	75	2	197	72	3	306	71	2
36	115	68	3	148	63	3	141	62	3	214	57	2
48	82	59	4	107	58	3	91	51	3	132	44	3
60	49	47	4	69	47	3	59	43	3	83	33	3
72	33	38	4	48	39	4	38	37	4	60	29	3
84	18	28	4	26	31	4	21	25	4	38	23	3
96	11	22	5	12	25	4	6	18	4	22	18	3
108	5	22	5	7	25	4	3	9	5	10	15	3
120	1	-	-	1	-	-	1	-	-	1	-	-

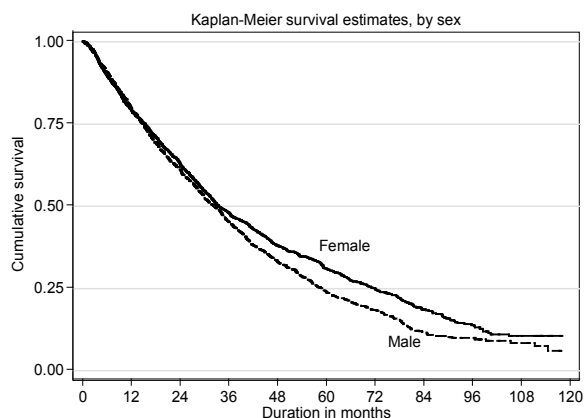
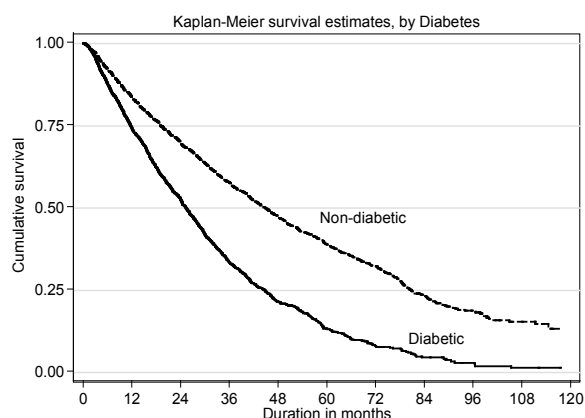
Age group (years) Interval (month)	45-54			55-64			≥65		
	n	% Survival	SE	n	% Survival	SE	n	% Survival	SE
0	1030	100	-	1172	100	-	906	100	-
6	884	91	1	974	89	1	692	83	1
12	731	81	1	780	77	1	501	66	2
24	472	61	2	483	57	2	272	45	2
36	295	45	2	272	40	2	128	28	2
48	187	33	2	144	28	2	49	16	2
60	116	26	2	77	20	2	27	10	2
72	67	19	2	46	14	2	15	7	2
84	30	12	2	20	8	1	6	4	1
96	14	10	2	6	5	2	4	3	1
108	6	7	2	1	-	-	2	2	1
120	1	-	-	1	-	-	1	-	-

**Figure 12.3.3:** Unadjusted technique survival by age, 2001-2010



**Table 12.3.4:** Unadjusted technique survival by Gender, 2001-2010

Gender Interval (months)	Male			Female		
	n	% survival	SE	n	% survival	SE
0	2413	100	-	2387	100	-
6	2045	91	1	1999	90	1
12	1651	80	1	1619	79	1
24	1042	61	1	1066	62	1
36	634	45	1	673	48	1
48	362	33	1	425	38	1
60	208	24	1	268	31	1
72	126	18	1	176	25	1
84	60	12	1	94	18	1
96	29	10	1	41	13	1
108	11	8	1	18	10	1
120	1	-	-	1	-	-

**Figure 12.3.4:** Unadjusted technique survival by Gender, 2001-2010**Figure 12.3.5:** Unadjusted technique survival by Diabetes status, 2001-2010**Table 12.3.5:** Unadjusted technique survival by Diabetes status, 2001-2010

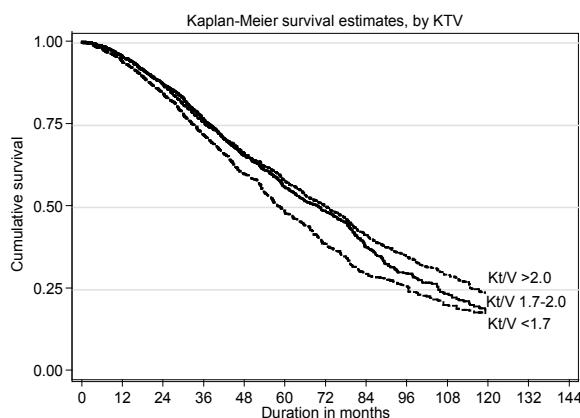
Diabetes status Interval (month)	Non-Diabetic			Diabetic		
	No.	% survival	SE	No.	% survival	SE
0	2719	100	-	2081	100	-
6	2310	92	1	1733	88	1
12	1867	84	1	1403	74	1
24	1276	70	1	831	52	1
36	881	58	1	426	33	1
48	592	47	1	195	21	1
60	385	39	1	90	13	1
72	263	32	1	39	8	1
84	140	23	1	14	4	1
96	64	18	1	6	3	1
108	26	15	2	3	1	1
120	1	-	-	1	-	-



**Table 12.3.6:** Unadjusted technique survival by Kt/V, 2001-2010

Kt/V Interval (months)	<1.7			1.7-2.0			>2.0		
	n	% Survival	SE	n	% Survival	SE	n	% Survival	SE
0	1974	100	-	2935	100	-	6031	100	-
6	1911	98	0	2853	99	0	5876	99	0
12	1780	94	1	2715	96	0	5547	95	0
24	1457	85	1	2313	87	1	4645	87	0
36	1124	72	1	1841	76	1	3621	75	1
48	811	60	1	1391	65	1	2753	66	1
60	596	48	1	1003	56	1	2053	58	1
72	411	39	1	750	49	1	1557	50	1
84	248	30	1	496	38	1	1051	41	1
96	156	26	1	283	30	1	680	34	1
108	90	20	1	170	23	1	456	29	1
120	58	18	1	87	18	1	273	24	1

**Figure 12.3.6:** Unadjusted technique survival by Kt/V, 2001-2010



**Table 12.3.7:** Adjusted hazard ratio for change of modality, 2001-2010

Factors	n	Hazard Ratio	95% CI	p value
<b>Age (years):</b>				
• Age 1-14 (ref*)	313	1.00		
• Age 15-24	404	1.37	(1.01;1.87)	1.006
• Age 25-34	411	1.71	(1.25; 2.34)	0.001
• Age 35-44	564	2.06	(1.52;2.78)	<0.001
• Age 45-54	1030	2.47	(1.85;3.29)	<0.001
• Age 55-64	1172	2.76	(2.07;3.67)	<0.001
• Age ≥65	906	3.61	(2.69;4.84)	<0.001
<b>Peritonitis</b>				
• No (ref*)	4459	1.00		
• Yes	341	2.71	(2.36;3.11)	<0.001
<b>Diabetes Mellitus</b>				
• Non-diabetic (ref*)	2719	1.00		
• Diabetic	2081	1.47	(1.32;1.65)	<0.001
<b>Gender:</b>				
• Male (ref*)	2413	1.00		
• Female	2387	0.86	(0.78;0.95)	0.008
<b>Cardiovascular Disease:</b>				
• No CVD (ref*)	3780	1.00		
• CVD	1020	1.13	(1.01;1.27)	0.038

**Table 12.3.7:** Adjusted hazard ratio for change of modality, 2001-2010 (cont'd.)

<b>BMI:</b>				
• <18.5	614	1.34	(1.13;1.58)	0.001
• 18.5-<25 (ref*)	2472	1.00		
• >=25	1714	0.98	(0.89;1.08)	0.674
<b>Serum Albumin:</b>				
• <30	1406	1.72	(1.52;1.95)	<0.001
• 30-<35	1845	1.10	(0.98;1.23)	0.117
• 35-<45 (ref*)	1512	1.00		
• >=45	37	1.07	(0.50;2.27)	0.866
<b>Serum Cholesterol:</b>				
• <3.2	88	1.54	(1.12;2.11)	0.008
• 3.2-<5.2 (ref*)	2429	1.00		
• >=5.2	2283	1.00	(0.91;1.10)	0.986
<b>Diastolic BP:</b>				
• <70	626	1.10	(0.94;1.28)	0.240
• 70-<80	1726	0.93	(0.84;1.04)	0.219
• 80-<90 (ref*)	1820	1.00		
• 90-<100	547	1.30	(1.10;1.52)	0.002
• >=100	81	1.95	(1.29;2.93)	0.001
<b>Hemoglobin:</b>				
• <8	218	1.65	(1.28;2.12)	<0.001
• 8-<9	525	1.68	(1.41;2.00)	<0.001
• 9-<10	1079	1.37	(1.19;1.58)	<0.001
• 10-<11	1550	1.03	(0.90;1.17)	0.676
• 11-<12 (ref*)	930	1.00		
• >=12	498	1.03	(0.86;1.23)	0.742
<b>Serum Calcium:</b>				
• <2.2	1918	0.98	(0.88;1.09)	0.736
• 2.2-<2.6 (ref*)	2751	1.00		
• >=2.6	131	1.85	(1.38;2.48)	<0.001
<b>Calcium Phosphate product:</b>				
• <3.5	2711	1.49	(1.25;1.76)	<0.001
• 3.5-<4.5 (ref*)	1396	1.00		
• 4.5-<5.5	506	0.90	(0.73;1.12)	0.365
• >=5.5	187	0.74	(0.50; 1.11)	0.145
<b>Serum Phosphate:</b>				
• <1.6 (ref*)	2832	1.00		
• 1.6-<2.0	1309	1.10	(0.93; 1.30)	0.274
• 2.0-<2.2	283	1.46	(1.09; 1.96)	0.012
• 2.2-<2.4	183	1.56	(1.09; 2.24)	0.017
• 2.4-<2.6	98	1.76	(1.12; 2.76)	0.015
• >=2.6	95	2.60	(1.54; 4.38)	<0.001
<b>Kt/V</b>				
• <1.7	745	1.01	(0.89; 1.16)	0.839
• 1.7-2.0 (ref*)	969	1.00		
• <=2	2079	0.99	(0.88; 1.10)	0.813
<b>Assisted PD</b>				
• Selfcare (ref*)	2555	1.00		
• Assisted	2127	1.37	(1.23; 1.53)	<0.001

**Table 12.3.8:** Reasons for Drop-out from PD program, 2001-2010

Year	2003		2004		2005		2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Death	195	77	156	60	182	61	177	58	230	66	277	64	320	65	317	65
Transplant	12	5	13	5	22	7	25	8	18	5	21	5	15	3	10	2
Peritonitis	15	6	38	15	29	10	33	11	36	10	50	11	76	15	75	15
Catheter related infection	0	0	5	2	2	1	2	1	4	1	4	1	11	2	13	3
Membrane failure	9	4	19	7	27	9	18	6	13	4	24	6	17	3	24	5
Technical problem	5	2	2	1	10	3	9	3	3	1	6	1	19	4	15	3
Patient preference	8	3	20	8	10	3	9	3	20	6	50	11	30	6	16	3
Others	7	3	9	3	7	2	16	5	14	4	2	0	3	1	16	3
Unknown	1	0	0	0	8	3	17	6	12	3	2	0	1	0	1	0
Total	252	100	262	100	297	100	306	100	350	100	436	100	492	100	487	100

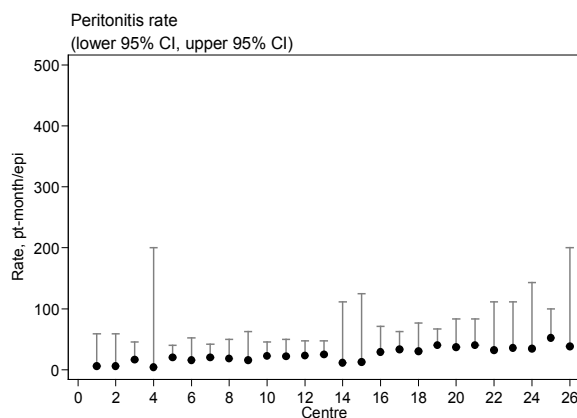
## SECTION 12.4: PERITONITIS

The median peritonitis rate for the year 2010 was 35.3 patient-months per episode (pt-month/epi) as shown in Table 12.4.1. There was a wide inter-centre variation with the highest and lowest rates of 10.8 and 84.9 patient-months per episode. Gram positive and gram negative organisms were each responsible for 29% of cases. *Staphylococcus Aureus* was the predominant organism (15%) amongst the gram positive bacteria. On the other hand, *E. Coli* emerged as the commonest gram negative organism (12%). The culture negative rate reduced to 30% compared to 36% in 2009 (Table 12.4.2). Fungal peritonitis remains at about 3% of all peritonitis cases. When comparing two eras of PD from 2001-2005 and 2006-2010 and outcomes by causative organisms, there is improvement in the proportion of cases achieving complete resolution and also less mortality. There is a higher tendency for catheter removal which may in part have accounted for the improved mortality rate. The exception was in mycobacterial peritonitis where there was a reduced catheter removal rate and slightly increased mortality in 2006-2010 compared with the previous era. This is most likely related to difficulty and delay in obtaining the diagnosis of mycobacterial peritonitis.

**Table 12.4.1:** Variation in peritonitis rate (pt-month/epi) among PD centres, 2001-2010

Year	Number of centres	Min	5 <sup>th</sup> Centile	LQ	Median	UQ	95 <sup>th</sup> Centile	Max
2001	11	10.8	10.8	19.9	23.6	41.3	60.3	60.3
2002	11	12.6	12.6	17.9	32.7	44.4	219.2	219.2
2003	13	18.2	18.2	21.3	32.9	39.6	312.1	312.1
2004	15	0	0	23.6	32.9	36.6	41.5	41.5
2005	15	18	18	26.3	35.6	43	57.7	57.7
2006	21	14.8	18.5	26.8	37.7	49.8	62.2	97.7
2007	23	12	12.9	30.7	42.1	56.6	68.4	106.7
2008	25	12	13	30	40.2	58.5	105.5	121.2
2009	25	14	17.1	29.8	38.2	55.8	115.7	245.8
2010	26	10.8	19.3	28.7	35.3	53.1	72.3	84.9

**Figure 12.4.1:** Variation in peritonitis rate among PD centres, 2010



**Table 12.4.2:** Causative organism in PD peritonitis, 2001-2010

Microorganism	2001		2002		2003		2004		2005		2006		2007		2008		2009		2010		
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
(A) Gram Positives																					
Staph. Aureus	40	13	62	17	45	12	52	14	39	12	51	14	47	13	46	10	53	11	75	15	
Staph Coagulase Neg.	30	10	39	11	47	13	41	11	42	13	32	9	29	8	49	11	51	10	54	11	
Strep	18	6	12	3	16	4	13	3	10	3	17	5	14	4	19	4	17	3	12	2	
Others	10	3	8	2	16	4	4	1	8	2	14	4	11	3	7	2	6	1	6	1	
(B) Gram Negatives																					
Pseudomonas	14	4	23	6	20	5	28	8	27	8	23	6	30	8	40	9	34	7	32	6	
Acinetobacter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Klebsiella	7	2	18	5	27	7	25	7	21	7	8	2	21	6	20	4	17	3	9	2	
Enterobacter	16	5	11	3	13	4	19	5	19	6	20	5	17	5	23	5	27	6	31	6	
E.Coli	16	5	23	6	20	5	23	6	30	9	15	4	32	9	42	9	41	8	60	12	
Others	17	5	15	4	15	4	16	4	17	5	14	4	14	4	11	2	22	4	17	3	
(C) Polymicrobial	11	4	8	2	3	1	2	1	0	0	1	0	0	0	0	0	13	3	4	1	
(D) Others																					
Fungal	21	7	12	3	12	3	15	4	7	2	16	4	20	5	24	5	18	4	15	3	
Mycobacterium	4	1	1	0	3	1	4	1	2	1	4	1	1	0	4	1	1	0	0	0	
Others	9	3	11	3	12	3	8	2	3	1	10	3	12	3	21	5	16	3	33	7	
(E) No growth	99	32	118	33	115	32	123	33	96	30	142	39	122	33	160	34	174	36	147	30	
TOTAL	312	100	361	100	364	100	373	100	321	100	367	100	370	100	466	100	490	100	495	100	

**Table 12.4.3(a):** Outcome of peritonitis by Causative organism, 2001-2005

	Outcome							
	Resolved		Not resolved, catheter removed		Death		Total	
	n	%	n	%	n	%	n	%
(A) Gram Positives								
Staph. Aureus	94	42	22	10	108	48	224	100
Staph Coagulase Neg.	78	42	14	8	94	51	186	100
Strep	25	40	6	10	31	50	62	100
Others	19	48	3	8	18	45	40	100
(B) Gram Negatives								
Pseudomonas	26	24	26	24	56	52	108	100
Acinetobacter	0		0		0		0	-
Klebsiella	37	39	14	15	43	46	94	100
Enterobacter	22	30	11	15	41	55	74	100
E.Coli	37	35	23	21	47	44	107	100
Others	24	32	19	26	31	42	74	100
(C) Polymicrobial	4	17	5	21	15	63	24	100
(D) Others								
Fungal	1	2	41	62	24	36	66	100
Mycobacterium	0	0	7	50	7	50	14	100
Others	10	26	4	11	24	63	38	100
(E) No growth	199	39	61	12	256	50	516	100

**Table 12.4.3(b):** Outcome of peritonitis by Causative organism, 2006-2010

Causative Organism	Outcome							
	Resolved		Not resolved, catheter removed		Death		Total	
	n	%	n	%	n	%	n	%
(A) Gram Positives								
Staph. Aureus	128	49	50	19	82	32	260	100
Staph Coagulase Neg.	134	65	20	10	53	26	207	100
Strep	37	49	7	9	31	41	75	100
Others	15	36	4	10	23	55	42	100
(B) Gram Negatives								
Pseudomonas	34	23	60	41	51	35	145	100
Acinetobacter	0		0		0		0	-
Klebsiella	21	30	21	30	28	40	70	100
Enterobacter	46	40	28	25	40	35	114	100
E.Coli	84	46	29	16	69	38	182	100
Others	37	51	19	26	17	23	73	100
(C) Polymicrobial	3	18	9	53	5	29	17	100
(D) Others								
Fungal	5	5	57	62	30	33	92	100
Mycobacterium	0	0	4	40	6	60	10	100
Others	46	52	23	26	19	22	88	100
(E) No growth	370	52	107	15	238	33	715	100

**Table 12.4.4:** Risk factor influencing peritonitis rate, 2001 -2010

Factors	n	Risk Ratio	95% CI	P value
<b>Age (years):</b>				
• <15	294	0.86	(10.70; 1.05)	0.140
• 15-24	228	0.93	(0.78;1.10)	0.396
• 25-34 (ref*)	310	1.00		
• 35-44	437	1.11	(0.95;1.29)	0.201
• 45-54	752	1.02	(0.88;1.19)	0.784
• 55-64	828	1.05	(0.90;1.24)	0.514
• >=65	543	0.91	(0.76;1.09)	0.301
<b>Gender:</b>				
• Male (ref*)	1700	1.00		
• Female	1692	0.98	(0.91;1.06)	0.667
<b>Diabetes:</b>				
• No (ref*)	1876	1.00		
• Yes	1516	1.04	(0.95;1.14)	0.385
<b>Income:</b>				
• RM 0-999 (ref*)	1370	1.00		
• RM 1000-1999	1139	0.89	(0.81;0.97)	0.006
• RM 2000-2999	508	0.87	(0.78;0.98)	0.024
• >=3000	375	0.80	(0.70;0.93)	0.003
<b>Education:</b>				
• Nil	312	1.20	(1.03;1.39)	0.016
• Primary	1186	1.08	(0.99;1.18)	0.074
• Secondary (ref*)	1186	1.00		
• Tertiary	308	0.85	(0.73;0.99)	0.042
<b>Assistance to perform CAPD:</b>				
• Self care (ref*)	1945	1.00		
• Partially assisted	493	0.87	(0.77;0.98)	0.026
• Completely assisted	954	0.97	(0.87; 1.07)	0.501
<b>Year vintage</b>				
• 1 to < 2 (ref*)	1987	1.00		
• >2 to < 4	885	0.63	(0.58; 0.69)	0.000
• > 4	520	0.50	(0.45;0.55)	0.000



# CHAPTER 13

## **RENAL TRANSPLANTATION**

Goh Bak Leong  
Wong Hin Seng  
Fan Kin Sing  
Rohan Malek Bin Johan  
Rosnawati Yahya  
S. Prasad Menon  
Tan Si Yen



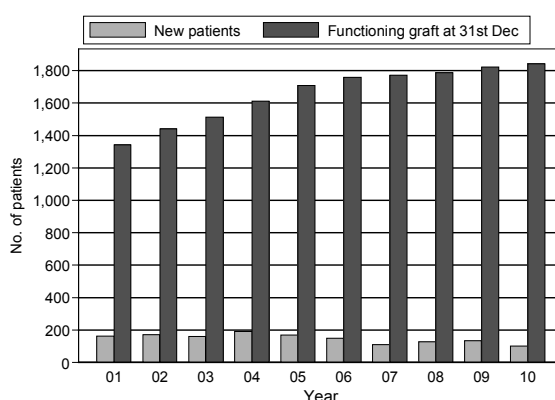
### SECTION 13.1: STOCK AND FLOW

The number of new renal transplant patients shows an initial rise from 163 transplants per year in 2001 to a peak of 192 transplants in 2004. This is a rise of nearly 18% but the number declined subsequently to only 102 in 2010 (Table 13.1.1). This is due to reduction in the number of transplantations done in oversea. As renal transplantation in the country is still dependant on the availability of commercial cadaveric transplantation done abroad, this drop is partially explained by the implementation of restriction of commercial organ transplantation by the Chinese Ministry of Health. The number of functioning renal transplants had increased from 1343 in 2001 to 1841 in 2010 (Table 13.1.1).

**Table 13.1.1:** Stock and Flow of Renal Transplantation, 2001-2010

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
New transplant patients	163	172	160	192	170	149	111	128	135	102
Died	40	38	42	44	47	58	46	60	49	33
Graft failure	39	33	41	43	21	36	36	39	35	45
Lost to Follow up	2	4	4	6	6	4	16	14	16	4
Functioning graft at 31 <sup>st</sup> December	1343	1440	1513	1612	1708	1759	1772	1787	1822	1841

**Figure 13.1.1:** Stock and Flow of Renal Transplantation, 2001-2010

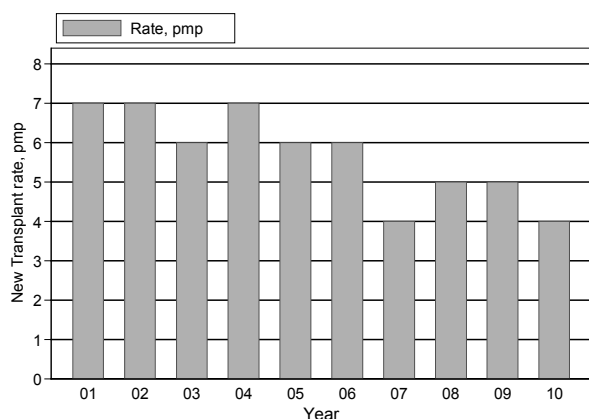


The incidence of renal transplantation shows a modest decline of 6 to 7 per million population in the early 2000's to 4-5 per million population in the last 3 years (Table 13.1.2) while transplant prevalence rate has grown slowly from 56 per million in 2001 to 65 per million population in 2005 (Table 14.1.3), an increase of 16% over the 2001 figures, and subsequently has remained static over the last five years. However, compared to growth in the prevalence rate of dialysis patients (which has increased by 325 from 326 per million population in 2001 to 812 in 2010) our transplant prevalence rate has not kept up. In fact, the incidence rate has reduced over the last ten years and the prevalence rate has remained static over the last 5 years (4 and 65 per million population respectively) (Table 13.1.2 and 13.1.3).

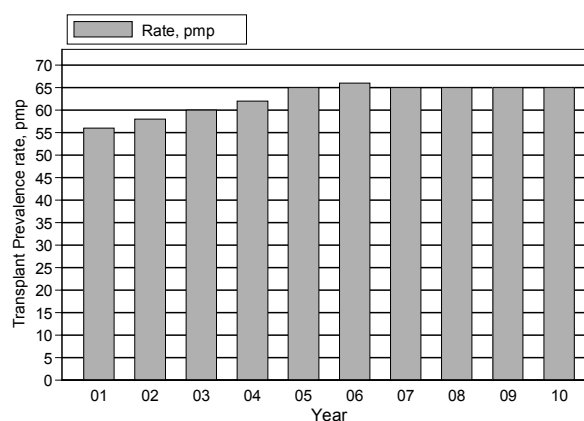
**Table 13.1.2:** New transplant rate per million population (pmp), 2001-2010

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
New transplant patients	163	172	160	192	170	149	111	128	135	102
New transplant rate, pmp	7	7	6	7	6	6	4	5	5	4

**Figure 13.1.2:** New transplant rate, 2001-2010



**Figure 13.1.3:** Transplant prevalence rate, 2001-2010



**Table 13.1.3:** Transplant prevalence rate per million population (pmp), 2001-2010

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Functioning graft at 31 <sup>st</sup> December	1343	1440	1513	1612	1708	1759	1772	1787	1822	1841
Transplant prevalence rate, pmp	56	58	60	62	65	66	65	65	65	65

In terms of place of transplantation, transplantation within local centres has remained relatively fluctuated in the last decade with 67 cases in 2001, gradually decreasing and was at its lowest in 2004 with only 40 cases and slowly increasing in the last 5 years. Unfortunately, the number of transplant has decreased again in 2010. This is disturbing data as it underscores our failure to improve rate of transplantation within the country, which is mainly due to the lack of both living as well as cadaver donors. Transplantation in China continues to drop from 139 cases (69%) at its peak in 2004 down to 35 cases (34%) in 2010 (Table 13.1.4).

**Table 13.1.4:** Place of transplantation, 2001-2010

Year	2001		2002		2003		2004		2005	
	n	%	n	%	n	%	n	%	n	%
HKL	33	20	30	17	26	16	20	10	31	18
UMMC	23	14	15	9	6	4	7	4	8	5
Selayang Hospital	11	7	11	6	11	7	11	6	5	3
Other local	4	3	1	1	1	1	2	1	4	2
China	83	51	103	60	111	69	139	72	110	65
India	8	5	12	7	4	3	11	6	7	4
Other overseas	1	1	0	0	1	1	2	1	4	2
Unknown	0	0	0	0	0	0	0	0	1	1
Total	163	100	172	100	160	100	192	100	170	100

Year	2006		2007		2008		2009		2010		TOTAL	
	n	%	n	%	n	%	n	%	n	%	n	%
HKL	35	24	36	32	32	25	36	27	25	25	304	21
UMMC	5	3	3	3	10	8	10	7	4	4	91	6
Selayang Hospital	9	6	14	13	10	8	19	14	18	18	119	8
Other local	2	1	4	4	8	6	10	7	8	8	44	3
China	87	58	45	41	63	49	58	43	35	34	834	56
India	7	5	3	3	3	2	1	1	1	1	57	4
Other overseas	4	3	5	5	2	2	1	1	3	3	23	2
Unknown	0	0	1	1	0	0	0	0	8	8	10	1
TOTAL	149	100	111	100	128	100	135	100	102	100	1482	100

## SECTION 13.2: RECIPIENTS' CHARACTERISTICS

In terms of renal transplant recipients' characteristics, age at transplant has remained unchanged, with a mean between 37 to 42 years old. Between 58% and 70% of recipients were males over the last 10 years.

The proportion of diabetic patients undergoing renal transplantation increased during the first half of the decade from 14% in 2001 to 18% in 2005 (Table 13.2.2). However, there is a drop in the number of diabetic patients who underwent transplantation in 2007 and dropped further to 12% in 2010. This coincided with the drop in China transplants where the majority of the diabetic patients underwent their transplantation.

Patients with hepatitis B have decreased from 5-8% earlier to 2% in the last 2 years. The proportion of patients with hepatitis C fluctuated in the last ten years. In terms of cause of end stage renal failure (Table 13.2.2), the primary cause was still glomerulonephritis, followed by hypertension and diabetes as the third cause. Up to 40% of transplant recipients had end stage renal disease due to unknown causes, belying the fact that majority of these patients presented late.

**Table 13.2.1:** Renal Transplant Recipients' Characteristics, 2001-2010

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
New Transplant Patients	163	172	160	192	170	149	111	128	135	102
Age at transplant (years), Mean	41	40	41	42	38	37	37	37	38	40
Age at transplant (years), SD	13	12	13	13	14	15	16	15	14	14
% Male	63	58	66	63	69	66	64	59	64	63
% Diabetic (co-morbid/ primary renal disease)	18	15	23	21	21	20	14	19	17	12
% HBsAg positive	5	7	8	5	4	7	7	3	2	2
% Anti-HCV positive	15	9	10	8	2	8	9	3	7	2

**Table 13.2.2:** Primary causes of end stage renal failure, 2001-2010

Year	2001		2002		2003		2004		2005	
	n	%	n	%	n	%	n	%	n	%
New transplant patients	163	100	172	100	160	100	192	100	170	100
Glomerulonephritis	44	27	54	31	55	34	64	33	47	28
Diabetes Mellitus	23	14	16	9	27	17	32	17	31	18
Hypertension	17	10	24	14	26	16	52	27	42	25
Obstructive uropathy	3	2	2	1	3	2	4	2	3	2
ADPKD	1	1	3	2	5	3	5	3	3	2
Drugs/ toxic nephropathy	0	0	0	0	2	1	2	1	0	0
Hereditary nephritis	0	0	0	0	0	0	1	1	0	0
Unknown	61	37	71	41	57	36	82	43	57	34
Others	23	14	15	9	12	8	28	15	14	8

Year	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
New transplant patients	149	100	111	100	128	100	135	100	102	100
Glomerulonephritis	53	36	31	28	33	26	40	30	38	37
Diabetes Mellitus	22	15	10	9	19	15	21	16	12	12
Hypertension	32	21	27	24	22	17	28	21	24	24
Obstructive uropathy	6	4	1	1	2	2	4	3	3	3
ADPKD	1	1	2	2	0	0	7	5	2	2
Drugs/ toxic nephropathy	1	1	0	0	2	2	0	0	0	0
Hereditary nephritis	0	0	0	0	0	0	0	0	1	1
Unknown	48	32	42	38	55	43	51	38	35	34
Others	16	11	14	13	12	9	3	2	6	6

### SECTION 13.3: TRANSPLANT PRACTICES

The proportion of commercial transplantation has gradually reduced from 79% at its peak in 2004 to 34% in 2010. This is predominantly due to the marked decline in commercial cadaveric transplantation (76% in 2004 to 10% in 2010), which is in keeping with the implementation of restriction of cadaveric organ transplantation by the Chinese Ministry of Health. However, the number of commercial live donation has increased in 2010.

Live donor transplantation made up 29% of transplants (25 recipients) in 2010, which was down from 41 cases (32%) in 2009 and 40 cases (32%) in 2008. The number of life donor has remained low.

Local cadaveric donation made up 18% of transplants (24 recipients) in 2006 although it had shown an initial promising rise to 37 recipients in 2010. 2010 also marked the first time in 10 years where there were more local transplantations (66%) compared to commercial transplantations in oversea (34%).

**Table 13.3.1:** Type of Renal Transplantation, 2001-2010

Year	2001		2002		2003		2004		2005	
	n	%	n	%	n	%	n	%	n	%
Commercial cadaver	83	51	103	60	112	70	145	76	107	64
Commercial live donor	7	4	11	6	3	2	6	3	9	5
Live donor (genetically related)	31	19	32	19	24	15	21	11	36	22
Live donor (emotionally related)	5	3	4	2	6	4	2	1	4	2
Cadaver	37	23	22	13	15	9	17	9	10	6
Total	163	100	172	100	160	100	191	100	166	100

Year	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
Commercial cadaver	85	58	45	41	60	48	33	26	8	10
Commercial live donor	8	5	4	4	2	2	20	16	20	24
Live donor (genetically related)	24	16	21	19	34	27	26	20	18	21
Live donor (emotionally related)	4	3	13	12	6	5	15	12	7	8
Cadaver	26	18	27	25	23	18	35	27	31	37
Total	147	100	110	100	125	100	129	100	84	100

\*Commercial Cadaver (China, India, other oversea) \*Commercial live donor (living unrelated) \*Cadaver (local)

**Table 13.3.2:** Biochemical data, 2006-2010

Biochemical parameter	Summary	2006	2007	2008	2009	2010
Creatinine, umol/L	n	1592	1688	1698	1695	1792
	Mean	135.7	131.8	131.9	128.1	131.1
	SD	81.3	77.6	80.8	62.8	88.1
	Median	120	116	115	115	112
	Minimum	21.7	36	29	10.7	10.3
	Maximum	1152	1186	1181	657	1145
Hb, g/dL	n	1592	1688	1698	1695	1792
	Mean	12.7	12.8	12.8	12.6	12.6
	SD	1.9	1.9	1.9	1.8	1.9
	Median	12.8	12.8	12.8	12.8	12.8
	Minimum	3.3	4.4	6.2	5.3	1.8
	Maximum	19.8	18.7	18.6	18.5	18.5
Albumin, g/L	n	1592	1688	1698	1695	1792
	Mean	39.7	39.8	39.8	39.7	39.7
	SD	0.7	0.8	0.8	1.2	1.4
	Median	39.7	39.7	39.7	39.7	39.7
	Minimum	29	29	30	21	24
	Maximum	48	48	50	50	75

**Table 13.3.2:** Biochemical data, 2006-2010 (cont'd)

Biochemical parameter	Summary	2006	2007	2008	2009	2010
Calcium, mmol/L	n	1592	1688	1698	1695	1792
	Mean	2.3	2.3	2.3	2.3	2.3
	SD	0.2	0.2	0.2	0.2	0.2
	Median	2.3	2.3	2.3	2.3	2.3
	Minimum	1.1	1.4	1	1.1	1.1
	Maximum	3.1	3.2	3.5	3.3	3.2
Phosphate, mmol/L	n	1592	1688	1698	1695	1792
	Mean	1.1	1.1	1.1	1.1	1.1
	SD	0.2	0.3	0.3	0.2	0.3
	Median	1.1	1.1	1.1	1.1	1.1
	Minimum	0.5	0.5	0.5	0.5	0.5
	Maximum	3.5	3.9	3.2	2.8	3.1
Alkaline Phosphate (ALP), U/L	n	1592	1688	1698	1695	1792
	Mean	79.1	79.4	79	80	82.3
	SD	43.2	39.8	46.4	45.3	56.5
	Median	71	72.5	72	73	73
	Minimum	24	22	20	21	20
	Maximum	700	508	985	732	964
ALT, U/L	n	1592	1688	1698	1695	1792
	Mean	29.8	29.8	30.1	29.9	27
	SD	30.4	25.6	37.8	32.5	24.8
	Median	22	23	23	24	21
	Minimum	4	4	4	4	4
	Maximum	433	356	881	881	410
Total cholesterol, mmol/L	n	1592	1688	1698	1695	1792
	Mean	5.3	5.2	5.2	5.2	5.2
	SD	1	1	1	1.1	1.1
	Median	5.3	5.3	5.3	5.3	5.3
	Minimum	1.5	1.7	2	1.9	2
	Maximum	11.1	11.4	11.2	10.6	11.5
LDL cholesterol, mmol/L	n	1592	1688	1698	1695	1792
	Mean	3	2.9	2.9	2.8	2.9
	SD	0.8	0.8	0.8	1	0.9
	Median	2.9	2.9	2.9	2.9	2.9
	Minimum	1	1	0.9	0.9	0.9
	Maximum	11.1	8.9	7.7	10.8	10.4
HDL cholesterol, mmol/L	n	1592	1688	1698	1695	1792
	Mean	1.6	1.5	1.6	1.5	1.5
	SD	0.5	0.4	0.5	0.5	0.5
	Median	1.6	1.6	1.6	1.6	1.6
	Minimum	0.4	0.4	0.5	0.4	0.4
	Maximum	5.8	7.5	7.5	6.9	6.8
Systolic Blood Pressure, mmHg	n	1592	1688	1698	1695	1792
	Mean	130.7	131.6	129.4	130.1	129.8
	SD	15.9	15.7	15.3	14.7	14.8
	Median	130	130	130	130	130
	Minimum	66	80	80	65	70
	Maximum	210	210	245	210	192
Diastolic Blood Pressure, mmHg	n	1592	1688	1698	1695	1792
	Mean	78.9	78.8	77.5	78.2	77.5
	SD	9.8	9.4	9.2	8.7	9.4
	Median	80	80	78.8	79	78.8
	Minimum	30	20	20	40	10
	Maximum	120	116	133	120	124

In 2010, Cyclosporine based regimes remained the mainstay of immunosuppressive therapy with 61% of patients receiving it. This showed a gradual declining trend from 76% of all immunosuppression used since 2006, which coincided with increasing trend in Tacrolimus usage. Tacrolimus based regimes has increased from 17% in 2006 to 30% in 2010. There has been continuous increase in the use of Mycophenolate Mofetil as the second immunosuppressive agent in 59% of patients in 2010 compared to 48% of patients in 2006. During the same period, the use of Azathioprine declined from 34% in 2006 to 27% in 2010. Monotherapy of immunosuppression is mostly not noted except in a small number of patients. Sirolimus was used in 1% of all transplant recipients in 2010.

In terms of non-immunosuppressive medications, in year 2010 only 26% of patients were on ACE inhibitors or Angiotensin II receptor blockers (AIIRB) or both and this trend has been relatively static since 2006. Calcium Channel blockers appeared to be the mainstay of antihypertensive therapy in 50% of patients whilst Beta Blockers use was reported in 38% of patients. Other antihypertensives were reported in 10% of patients. The widespread use of Calcium Channel blockers either as monotherapy or combination may be due to the use of the dihydropyridine group to minimize the dose of Cyclosporine, which remains the main immunosuppressive drug.

**Table 13.3.3:** Medication data, 2006-2010

Medication data	Single drug treatment									
	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
All	1482	100	1666	100	1429	100	1747	100	1432	100
<b>(i) Immunosuppressive drug(s) treatment</b>										
Prednisolone	8	1	9	1	6	0	6	0	11	1
Azathioprine	0	0	0	0	0	0	1	0	0	0
Cyclosporin A	5	0	8	0	2	0	15	1	5	0
Tacrolimus (FK506)	0	0	4	0	3	0	14	1	2	0
Mycophenolate Mofetil (MMF)	0	0	1	0	2	0	0	0	1	0
Rapamycin	0	0	0	0	1	0	0	0	0	0
Others	0	0	0	0	0	0	1	0	0	0
<b>(ii) Non-Immunosuppressive drug(s) treatment</b>										
Beta blocker	77	5	90	5	88	6	118	7	130	9
Calcium channel blocker	199	13	184	11	138	10	161	9	185	13
ACE inhibitor	39	3	38	2	29	2	41	2	35	2
AIIRB	27	2	19	1	17	1	21	1	31	2
Anti-lipid	156	11	95	6	89	6	117	7	109	8
Other anti-hypertensive	11	1	6	0	25	2	26	1	21	1

Medication data	Combined drug treatment									
	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
All	1482	100	1666	100	1429	100	1747	100	1432	100
<b>(i) Immunosuppressive drug(s) treatment</b>										
Prednisolone	1444	97	1612	97	1385	97	1645	94	1356	95
Azathioprine	497	34	479	29	382	27	385	22	388	27
Cyclosporin A	1119	76	1191	71	983	69	1122	64	873	61
Tacrolimus (FK506)	254	17	349	21	345	24	475	27	434	30
Mycophenolate Mofetil (MMF)	708	48	908	55	776	54	1048	60	852	59
Rapamycin	7	0	33	2	30	2	32	2	20	1
Others	18	1	4	0	1	0	26	1	41	3
<b>(ii) Non-Immunosuppressive drug(s) treatment</b>										
Beta blocker	597	40	735	44	615	43	681	39	540	38
Calcium channel blocker	787	53	905	54	687	48	736	42	573	40
ACE inhibitor	292	20	384	23	287	20	311	18	215	15
AIIRB	141	10	211	13	141	10	146	8	153	11
Anti-lipid	679	46	732	44	627	44	710	41	513	36
Other anti-hypertensive	159	11	140	8	191	13	167	10	142	10

## SECTION 13.4: TRANSPLANT OUTCOMES

### 13.4.1: Post-transplant complications

In the year 2010, 58% of patients were hypertensive prior to transplantation whereas 27% developed hypertension post transplantation. Thirteen percent of patients had diabetes mellitus prior to transplant whereas only 6% of patients developed post transplant diabetes mellitus. These trends have been quite the same since 2006. In terms of cardiovascular and cerebrovascular disease 3% had either or both prior to transplant and another 3% developed these post transplantation.

**Table 13.4.1:** Post-transplant complications, 2006-2010

Medication data	Pre transplant									
	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
All patients	1592	100	1688	100	1705	100	1710	100	1824	100
Diabetes (either as Primary Renal Disease or co-morbid)	218	14	232	14	233	14	211	12	239	13
Cancer	2	0	3	0	2	0	1	0	2	0
Cardiovascular disease + cerebrovascular disorder	73	5	72	4	67	4	51	3	60	3
Hypertension	1036	65	1063	63	1055	62	1028	60	1059	58
	Post transplant									
All patients	1592	100	1688	100	1705	100	1710	100	1824	100
Diabetes (either as Primary Renal Disease or co-morbid)	124	8	113	7	119	7	88	5	114	6
Cancer	20	1	21	1	24	1	16	1	19	1
Cardiovascular disease + cerebrovascular disorder	45	3	54	3	72	4	56	3	48	3
Hypertension	354	22	451	27	413	24	448	26	498	27

\*Hypertension: BP systolic >140 and BP diastolic >90

OR have either Beta blocker/ Calcium channel blocker / ACE inhibitor / AIIIRB / Other anti-hypertensive

### 13.4.2: Deaths and Graft loss

In 2010, 33 transplant recipients died and 45 lost their grafts. The rates of transplant death and graft loss have remained static for the past 10 years (Table 13.4.2). The main known causes of death have been infection and cardiovascular disease with 37% and 18% respectively. Another 18% of patients died at home, which is usually presumed to be cardiovascular death as well.

Cancer death rates have been significantly high since 2001 contributing to 13% of all deaths in 2001, 18% in 2008 and 13% in 2009. Death due to liver disease has remained relatively static at 3% and 4% in 2009 and 2010 respectively.

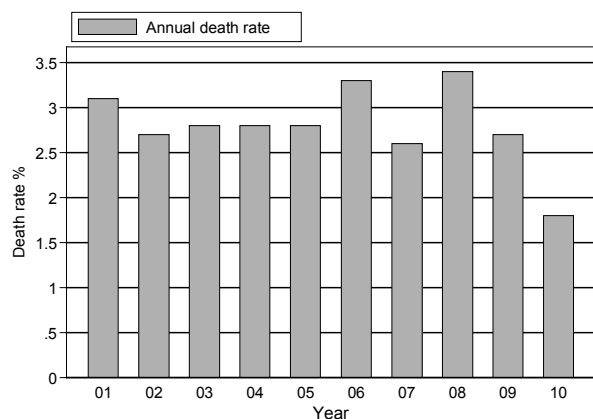
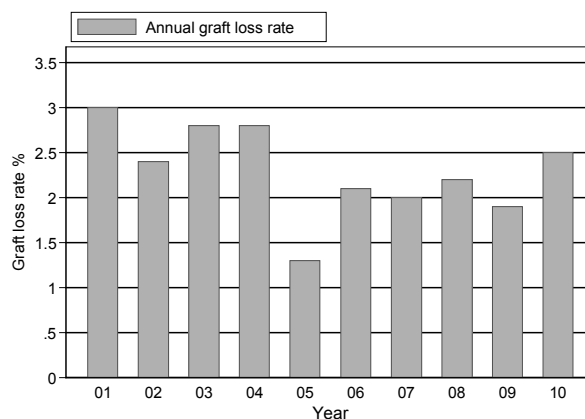
In terms of graft loss, majority were due to rejection.

**Table 13.4.2:** Transplant Patients Death Rate and Graft Loss, 2001-2010

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Number at risk	1302	1392	1477	1563	1660	1734	1766	1780	1805	1832
Transplant death	40	38	42	44	47	58	46	60	49	33
Transplant death rate %	3.1	2.7	2.8	2.8	2.8	3.3	2.6	3.4	2.7	1.8
Graft loss	39	33	41	43	21	36	36	39	35	45
Graft loss rate %	3	2.4	2.8	2.8	1.3	2.1	2	2.2	1.9	2.5
Acute rejection	0	0	4	19	14	19	14	23	31	70
Acute rejection rate %	0	0	0.3	1.2	0.8	1.1	0.8	1.3	1.7	3.8
All losses	79	71	83	87	68	94	82	99	84	78
All losses rate %	6.1	5.1	5.6	5.6	4.1	5.4	4.6	5.6	4.7	4.3

\*Graft loss=graft failure

\*All losses=death / graft loss (acute rejection happens concurrently with graft failure / death)

**Figure 13.4.2(a): Transplant Recipient Death Rate, 2001-2010****Figure 13.4.2(b): Transplant Recipient Graft Loss Rate, 2001-2010****Table 13.4.3: Causes of Death in Transplant Recipients, 2001-2010**

Year	2001		2002		2003		2004		2005	
	n	%	n	%	n	%	n	%	n	%
Cardiovascular	7	15	6	15	14	30	6	13	5	10
Died at home	5	11	5	13	5	11	5	11	6	13
Infection	22	48	14	35	14	30	17	36	27	56
Graft failure	0	0	0	0	0	0	3	6	0	0
Cancer	6	13	5	13	7	15	8	17	5	10
Liver disease	2	4	5	13	3	6	4	9	3	6
Accidental death	1	2	1	3	1	2	0	0	1	2
Others	0	0	2	5	1	2	3	6	0	0
Unknown	3	7	2	5	2	4	1	2	1	2
TOTAL	46	100	40	100	47	100	47	100	48	100

Year	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
Cardiovascular	13	21	9	18	11	17	12	22	7	18
Died at home	7	11	5	10	12	18	9	17	7	18
Infection	25	40	18	35	20	30	19	35	14	37
Graft failure	0	0	4	8	0	0	1	2	1	3
Cancer	5	8	6	12	12	18	7	13	3	8
Liver disease	5	8	0	0	0	0	2	4	1	3
Accidental death	1	2	0	0	0	0	0	0	0	0
Others	2	3	1	2	5	8	1	2	4	11
Unknown	5	8	8	16	6	9	3	6	1	3
TOTAL	63	100	51	100	66	100	54	100	38	100



**Table 13.4.4:** Causes of Graft Failure, 2001-2010

Year	2001		2002		2003		2004		2005	
	n	%	n	%	n	%	n	%	n	%
Rejection	24	60	19	54	20	47	29	67	15	68
Calcineurin toxicity	0	0	1	3	1	2	0	0	0	0
Other drug toxicity	0	0	0	0	0	0	0	0	0	0
Ureteric obstruction	0	0	0	0	0	0	0	0	0	0
Infection	2	5	0	0	2	5	1	2	1	5
Vascular causes	1	3	0	0	3	7	4	9	2	9
Recurrent/ de novo renal disease	2	5	2	6	2	5	1	2	0	0
Others	0	0	3	9	1	2	0	0	1	5
Unknown	11	28	10	29	14	33	8	19	3	14
TOTAL	40	100	35	100	43	100	43	100	22	100

Year	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
Rejection	25	68	25	69	27	64	23	62	25	54
Calcineurin toxicity	0	0	0	0	0	0	1	3	1	2
Other drug toxicity	0	0	0	0	0	0	1	3	1	2
Ureteric obstruction	0	0	1	3	0	0	0	0	0	0
Infection	2	5	1	3	3	7	1	3	0	0
Vascular causes	4	11	1	3	3	7	1	3	3	7
Recurrent/ de novo renal disease	1	3	0	0	1	2	0	0	0	0
Others	2	5	3	8	2	5	0	0	4	9
Unknown	3	8	5	14	6	14	10	27	12	26
TOTAL	37	100	36	100	42	100	37	100	46	100

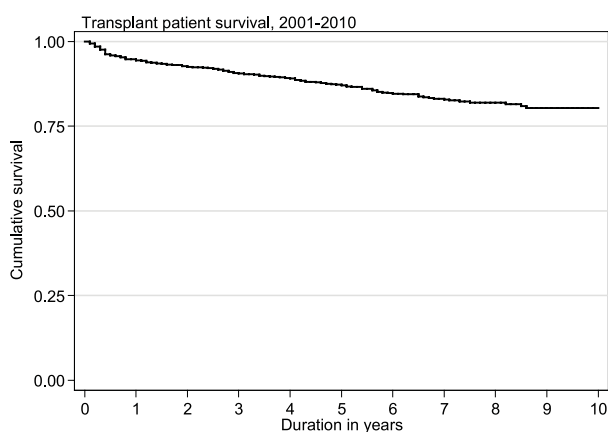
## SECTION 13.5: PATIENT AND GRAFT SURVIVAL

Overall patient survival rates from 2001 to 2010 have been 94%, 91%, 87% and 80% at year 1, 3, 5 and 10 respectively. Overall graft survival rate has been 93%, 87%, 81% and 68% at year 1, 3, 5 and 10 respectively.

**Table 13.5.1(a):** Patient survival, 2001-2010

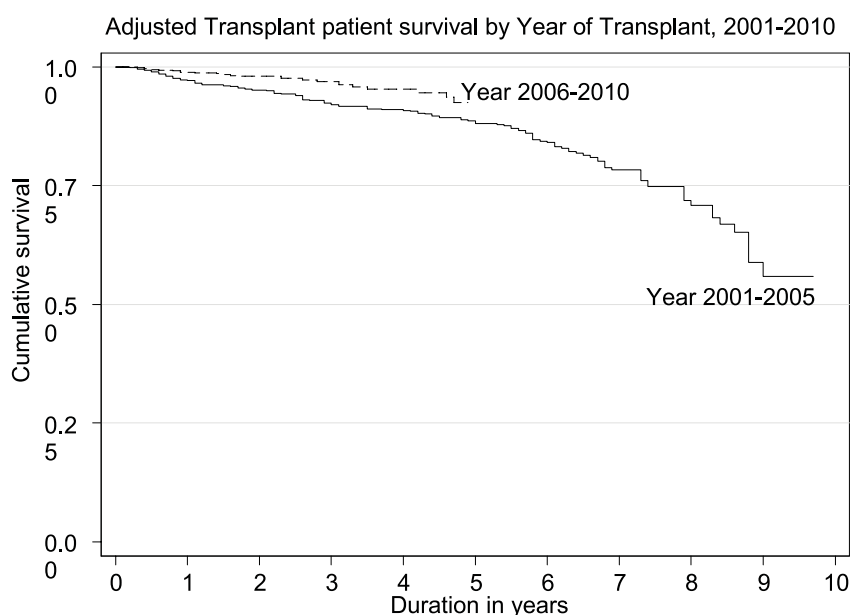
Interval (years)	n	% Survival	SE
0	1482	100	
1	1263	94	1
2	1097	93	1
3	952	91	1
4	818	89	1
5	670	87	1
6	494	85	1
7	337	83	1
8	209	82	1
9	95	80	2
10	4	80	2

\*n=Number at risk SE=standard error

**Figure 13.5.1(a):** Patient survival, 2001-2010

**Table 13.5.1(b):** Risk factors for transplant patient survival 2001-2010

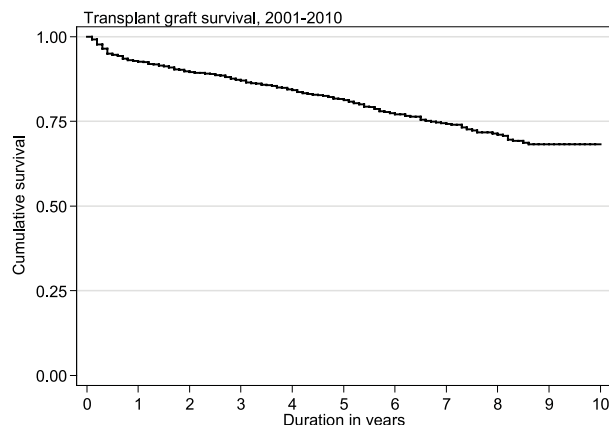
Factors	n	Hazard Ratio	95% CI	P value
Year of transplant				
• 2001-2005 (ref <sup>*</sup> )	857	1.00		
• 2006-2010	625	1.46	(0.99;2.17)	0.057
Age at transplant				
• <20	148	0.35	(0.15; 0.82)	0.016
• 20-39 (ref <sup>*</sup> )	554	1.00		
• 40-54	670	1.81	(1.25; 2.63)	0.002
• ≥55	110	2.00	(1.18; 3.37)	0.010
Gender:				
• Male (ref <sup>*</sup> )	938	1.00		
• Female	544	0.97	(0.70; 1.34)	0.857
Primary diagnosis:				
• Unknown primary (ref <sup>*</sup> )	773	1.00		
• Diabetes mellitus	126	1.22	(0.77; 1.94)	0.394
• GN/SLE	352	0.84	(0.56; 1.26)	0.398
• Polycystic kidney	24	0.52	(0.13; 2.19)	0.377
• Obstructive nephropathy	42	1.80	(0.78; 4.11)	0.166
• Others	165	0.96	(0.60; 1.55)	0.882
Type of transplant				
• Commercial cadaver (ref <sup>*</sup> )	781	1.00		
• Commercial live donor	87	0.82	(0.40;1.69)	0.591
• Living donor	342	0.67	(0.41;1.10)	0.113
• Cadaver	243	2.62	(1.80;3.81)	<0.001
HbsAg				
• Negative (ref <sup>*</sup> )	1,452	1.00		
• Positive	30	1.75	(0.90; 3.41)	0.098
Anti-HCV				
• Negative (ref <sup>*</sup> )	1,436	1.00		
• Positive	46	1.50	(0.88; 2.55)	0.140

**Figure 13.5.1(b):** Adjusted Transplant Patient Survival related to Year of Transplant, 2001-2010  
(adjusted for age, gender, primary diagnosis, type of transplant, HBSAg and Anti-HCV status)

**Table 13.5.2 (a):** Graft survival, 2001-2010

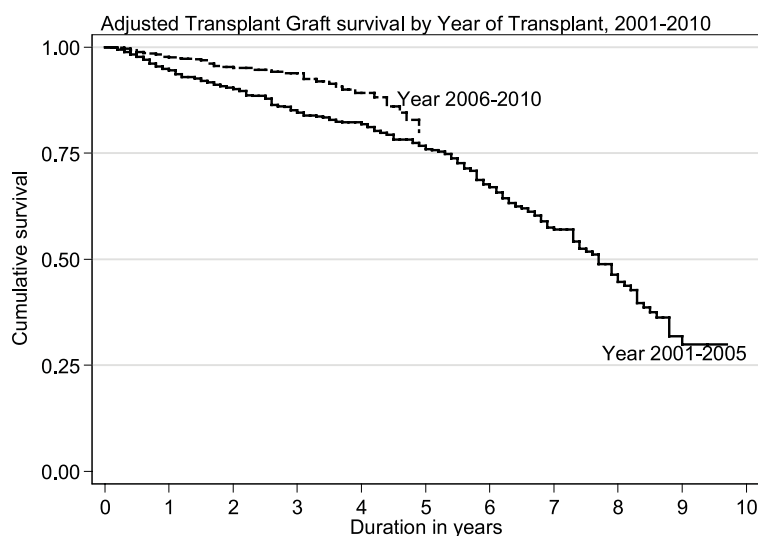
Interval (years)	n	% Survival	SE
0	1482	100	-
1	1263	92.61	0.69
2	1097	89.55	0.83
3	952	87.07	0.93
4	818	84.21	1.04
5	670	81.31	1.15
6	494	77.12	1.32
7	337	74.28	1.46
8	209	71.11	1.69
9	95	68.22	1.95
10	4	68.22	1.95

\*n=Number at risk SE=standard error

**Figure 13.5.2 (a):** Graft survival, 2001-2010**Table 13.5.2(b):** Risk factors for transplant graft survival 2001-2010

Factors	n	Hazard Ratio	95% CI	P value
<b>Year of transplant</b>				
• 2001-2005 (ref <sup>*</sup> )	857	1.00		
• 2006-2010	625	1.46	(0.99;2.17)	0.06
<b>Age at transplant</b>				
• <20	148	0.35	(0.15; 0.82)	0.02
• 20-39 (ref <sup>*</sup> )	554	1.00		
• 40-54	670	1.81	(1.25;2.63)	0.00
• ≥55	110	2.00	(1.18;3.37)	0.01
<b>Gender:</b>				
• Male (ref <sup>*</sup> )	938	1.00		
• Female	544	0.97	(0.70; 1.34)	0.86
<b>Primary diagnosis:</b>				
• Unknown primary (ref <sup>*</sup> )	773			
• Diabetes mellitus	126	1.22	(0.77; 1.94)	0.39
• GN/SLE	352	0.84	(0.56; 1.26)	0.40
• Polycystic kidney	24	0.52	(0.13; 2.19)	0.38
• Obstructive nephropathy	42	1.80	(0.78; 4.11)	0.17
• Others	165	0.96	(0.60; 1.55)	0.88
<b>Type of transplant</b>				
• Commercial cadaver (ref <sup>*</sup> )	781	1.00		
• Commercial live donor	87	0.82	(0.40; 1.69)	0.59
• Living donor	342	0.67	(0.41; 1.10)	0.11
• Cadaver	243	2.62	(1.80; 3.81)	0.00
<b>HbsAg</b>				
• Negative (ref <sup>*</sup> )	1,452	1.00		
• Positive	30	1.75	(0.90; 3.41)	0.10
<b>Anti-HCV</b>				
• Negative (ref <sup>*</sup> )	1,436	1.00		
• Positive	46	1.50	(0.88; 2.55)	0.14

**Figure 13.5.2(b):** Adjusted Transplant Graft Survival related to Year of Transplant, 2001-2010  
(adjusted for age, gender, primary diagnosis, type of transplant, HBsAg and Anti-HCV status)



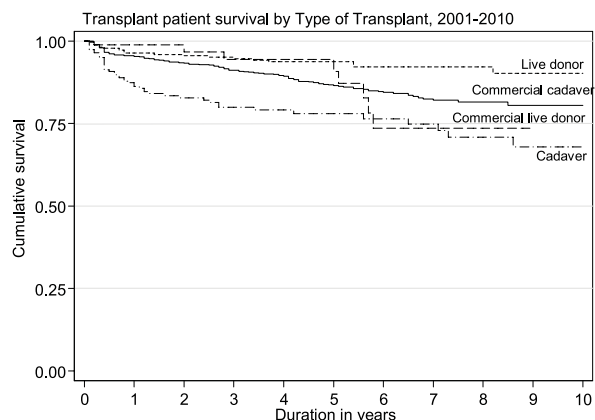
Outcomes of renal transplantation from the 4 donor groups are shown in Figures 13.5.3 and 13.5.4. In terms of patient survival, live donor grafts maintained good survival rates with 96%, 95%, 94% and 90% at years 1, 3, 5 and 10 respectively. In terms of graft survival, commercial cadaver grafts performed similarly well with a survival of 94%, 89%, 82% and 72% at year 1, 3, 5 and 10 compared to 95%, 92%, 90% and 72% for the same intervals for live donor grafts.

**Table 13.5.3:** Unadjusted Patient survival by type of transplant, 2001-2010

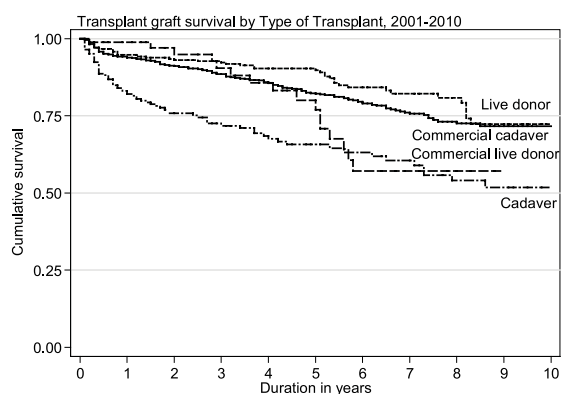
Type of Transplant	Commercial Cadaver			Commercial Live Donor			Live Donor			Cadaver		
	Interval (years)	n	% Survival	SE	n	% Survival	SE	n	% Survival	SE	n	% Survival
0	781	100	0	81	100	0	342	100	0	243	100	0
1	724	95	1	69	99	1	289	96	1	165	86	2
2	667	93	1	49	97	2	245	95	1	125	83	3
3	589	91	1	45	95	3	208	95	1	103	80	3
4	528	89	1	38	95	3	168	94	2	78	79	3
5	436	86	1	29	91	4	141	94	2	59	78	3
6	334	84	1	16	75	8	95	92	2	49	76	3
7	210	82	2	11	75	8	76	92	2	42	75	4
8	122	81	2	7	75	8	52	92	2	28	71	4
9	51	80	2	2	75	8	24	90	3	18	68	5
10	1	80	2	2	0	0	1	90	3	2	68	5

\*n=Number at risk SE=standard error

**Figure 13.5.3:** Patient survival by type of transplant, 2001-2010



**Figure 13.5.4:** Graft survival by type of transplant, 2001-2010



**Table 13.5.4:** Graft survival by type of transplant, 2001-2010

Type of Transplant	Commercial Cadaver			Commercial Live Donor			Live Donor			Cadaver		
	Interval (years)	n	% Survival	SE	n	% Survival	SE	n	% Survival	SE	n	% Survival
0	781	100	0	87	100	0	342	100	0	243	100	0
1	724	94	1	66	99	1	297	95	1	165	82	3
2	667	91	1	46	95	3	252	93	1	125	76	3
3	589	89	1	42	91	4	215	92	2	103	72	3
4	528	86	1	35	86	5	174	90	2	78	68	4
5	436	82	1	26	77	7	145	90	2	59	66	4
6	334	79	2	16	57	9	95	84	3	49	63	4
7	210	76	2	11	57	9	76	82	3	42	61	4
8	122	73	2	7	57	9	52	81	3	28	54	5
9	51	72	2	2	57	9	24	72	5	18	52	5
10	1	72	2	2	0	0	1	72	5	2	52	5

\*n=Number at risk SE=standard error

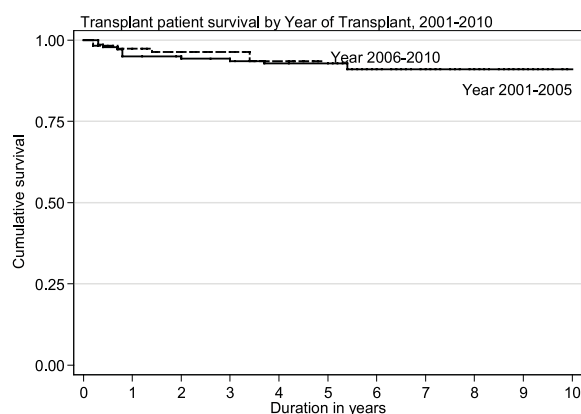
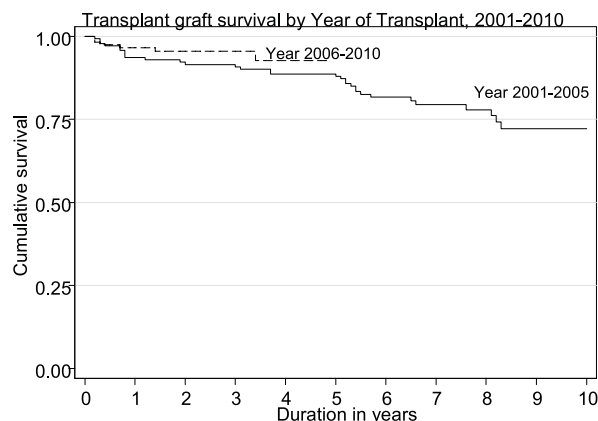
Patient and graft survival for living related transplants were compared between two cohorts. The patient survival for 2001-2005 cohort and the 2006-2010 cohort were comparable (Figures 13.5.5).

However, graft survival for living related transplants (Figure 13.5.6) was better in patients in the 2006-2010 cohort even from the outset probably due to increased usage of newer immunosuppressive agents.

**Table 13.5.5:** Patient survival by year of transplant (Living related transplant, 2001-2010)

Year of Transplant	2001-2005			2006-2010		
	Interval (years)	n	% Survival	SE	n	% Survival
0	144	100	-	123	100	-
1	136	95	2	102	97	1
2	131	94	2	73	96	2
3	129	94	2	45	96	2
4	127	93	2	26	94	3
5	124	93	2	2	94	3
6	82	91	2	-	-	-
7	64	91	2	-	-	-
8	45	91	2	-	-	-
9	21	91	2	-	-	-
10	1	91	2	-	-	-

\*n=Number at risk SE=standard error

**Figure 13.5.5:** Patient survival by year of transplant  
(Living related transplant, 2001-2010)**Figure 13.5.6:** Graft survival by year of transplant  
(Living related transplant, 2001-2010)**Table 13.5.6:** Graft survival by year of transplant (Living related transplant, 2001-2010)

Year of Transplant	2001-2005			2006-2010		
Interval (years)	n	% Survival	SE	n	% Survival	SE
0	144	100	-	123	100	-
1	136	94	2	102	97	2
2	131	92	2	73	96	2
3	129	91	2	45	96	2
4	127	89	3	26	93	3
5	124	88	3	-	-	-
6	82	82	3	-	-	-
7	64	79	4	-	-	-
8	45	78	4	-	-	-
9	21	72	5	-	-	-
10	1	72	5	-	-	-

\*n=Number at risk SE=standard error

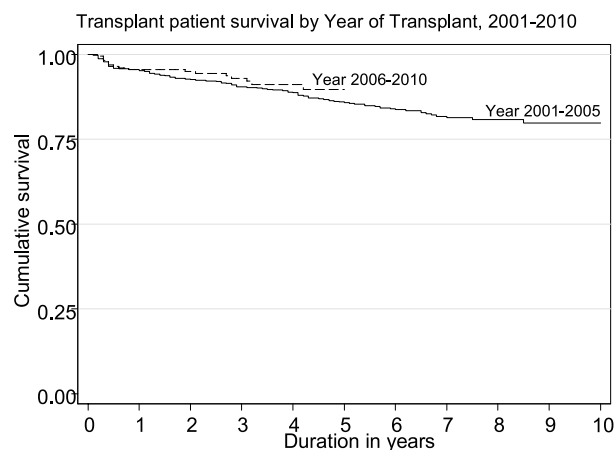
Patient and graft survival for commercial transplants were comparable between the 2001-2005 cohort and the 2006-2010 cohort (Figures 13.5.7). This result was also comparable to the living related renal transplant done in the country.

**Table 13.5.7:** Patient survival by year of transplant (Commercial cadaver transplant, 2001-2010)

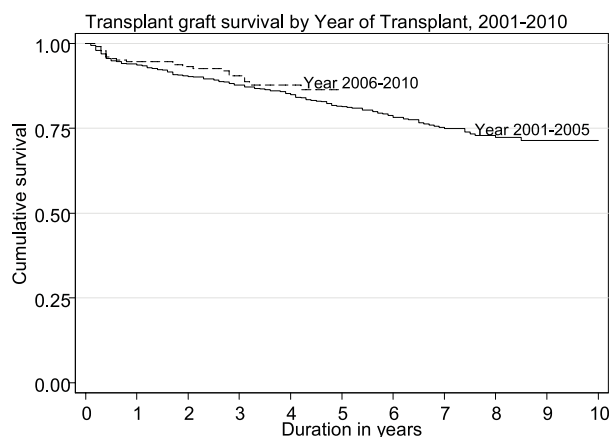
Year of Transplant	2001-2005			2006-2010		
Interval (years)	n	% Survival	SE	n	% Survival	SE
0	550	100	-	231	100	-
1	512	95	1	212	96	1
2	491	93	1	176	95	1
3	476	90	1	116	93	2
4	455	89	1	73	91	2
5	434	86	2	2	90	3
6	334	84	2	-	-	-
7	210	81	2	-	-	-
8	122	81	2	-	-	-
9	51	80	2	-	-	-
10	1	80	2	-	-	-

\*n=Number at risk SE=standard error

**Figure 13.5.7:** Patient survival by year of transplant  
(Commercial cadaver transplant, 2001-2010)



**Figure 13.5.8:** Graft survival by year of transplant  
(Commercial cadaver transplant, 2001-2010)



**Table 13.5.8:** Graft survival by year of transplant (Commercial cadaver transplant, 2001-2010)

Year of Transplant Interval (years)	2001-2005			2006-2010		
	n	% Survival	SE	n	% Survival	SE
0	550	100	-	231	100	-
1	512	94	1	212	95	1
2	491	90	1	176	93	2
3	476	88	1	116	90	2
4	455	85	2	73	88	3
5	434	81	2	2	86	3
6	334	78	2	-	-	-
7	210	75	2	-	-	-
8	122	72	2	-	-	-
9	51	71	2	-	-	-
10	1	71	2	-	-	-

\*n=Number at risk SE=standard error

## SECTION 13.6: CARDIOVASCULAR RISK IN RENAL TRANSPLANT RECIPIENTS

### 13.6.1: Risk factors for Ischaemic Heart Disease

In 2010, 86.8% of patients were hypertensive, 21.2% were diabetic and 48.3% had renal insufficiency fulfilling CKD III and above. Forty-three percent of patients had 2 cardiovascular risk factors while 6.5% had all 3 major risk factors.

**Table 13.6.1:** Risk factors for IHD in renal transplant recipients at year 2006-2010

	2006	2007	2008	2009	2010
Diabetes	21 (1.4)	25 (1.6)	18 (1.1)	28 (1.8)	33 (2.0)
Hypertension**	454 (31.0)	588 (37.3)	664 (41.8)	646 (41.1)	627 (38.3)
CKD	177 (12.1)	127 (8.1)	117 (7.4)	156 (9.9)	163 (9.9)
Diabetes + Hypertension**	156 (10.7)	177 (11.2)	203 (12.8)	163 (10.4)	187 (11.4)
Diabetes + CKD	18 (1.2)	11 (0.7)	22 (1.4)	18 (1.1)	22 (1.3)
CKD + Hypertension**	490 (33.5)	517 (32.8)	457 (28.7)	474 (30.2)	501 (30.6)
Diabetes + CKD + Hypertension**	147 (10.0)	132 (8.4)	109 (6.9)	86 (5.5)	106 (6.5)

\*\*Hypertension: BP systolic > 140 and BP diastolic > 90

OR have either Beta blocker / Calcium channel blocker / ACE inhibitor / AIIIRB / Other anti-hypertensive drugs

GFR (mL/min/1.73m<sup>2</sup>) = 1.2\*(140-age(year))\*weight(kg) / creatinine (µmol/L) if male

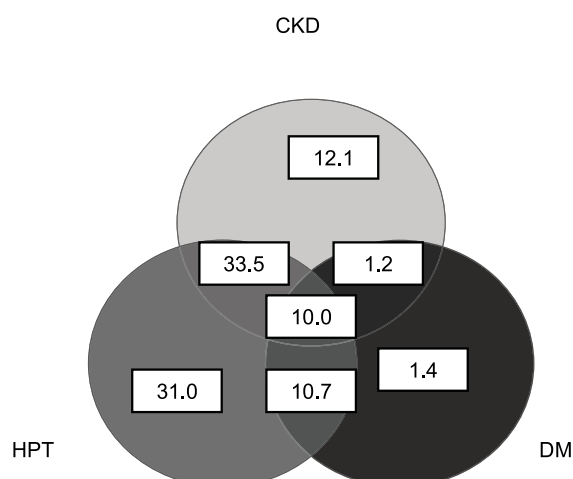
GFR (mL/min/1.73m<sup>2</sup>) = 0.85\*(1.2\*(140-age(year))\*weight(kg) / creatinine (µmol/L) if female

CKD stage III-GFR, 30-60

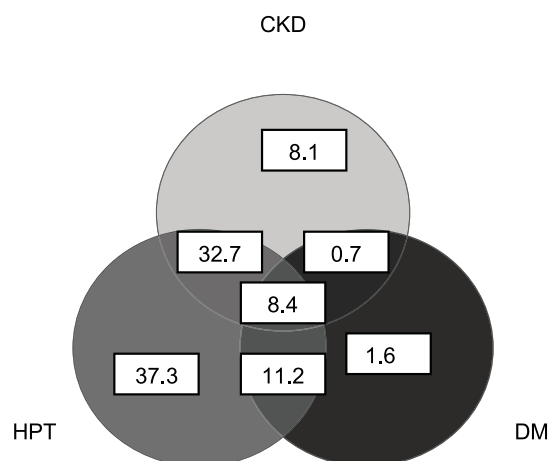
CKD stage IV-GFR, 15-30

CKD stage V-GFR, <15

**Figure 13.6.1(a):** Venn Diagram for Pre and Post Transplant Complications (in %) at year 2006

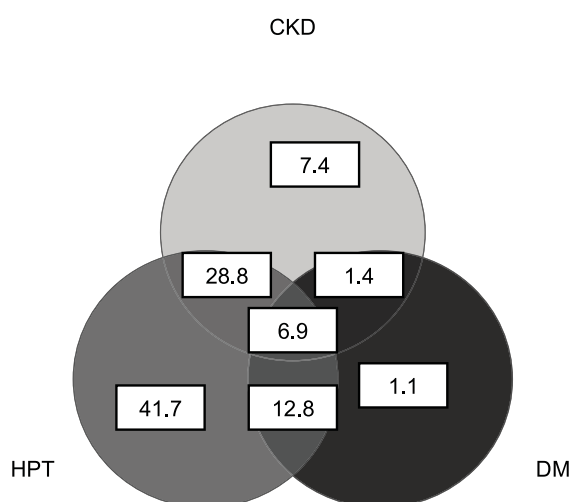


**Figure 13.6.1(b):** Venn Diagram for Pre and Post Transplant Complications (in %) at year 2007

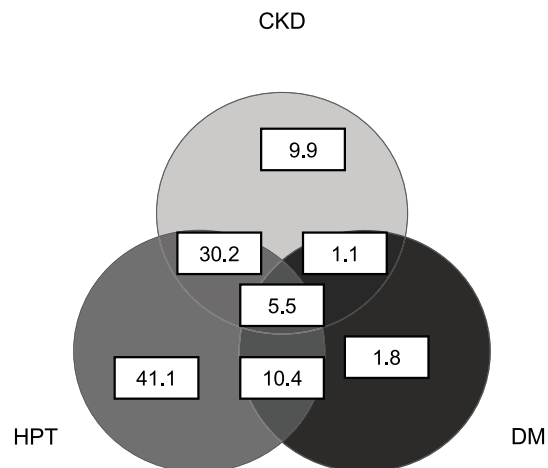




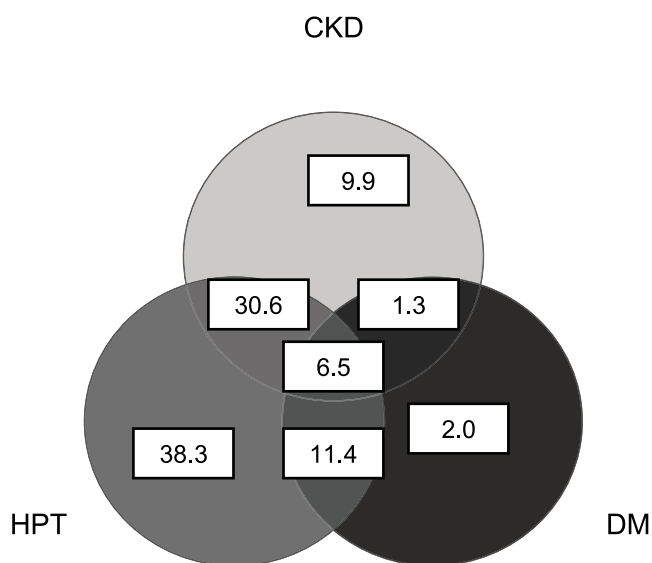
**Figure 13.6.1(c):** Venn Diagram for Pre and Post Transplant Complications (in %) at year 2008



**Figure 13.6.1(d):** Venn Diagram for Pre and Post Transplant Complications (in %) at year 2009



**Figure 13.6.1(e):** Venn Diagram for Pre and Post Transplant Complications (in %) at year 2010

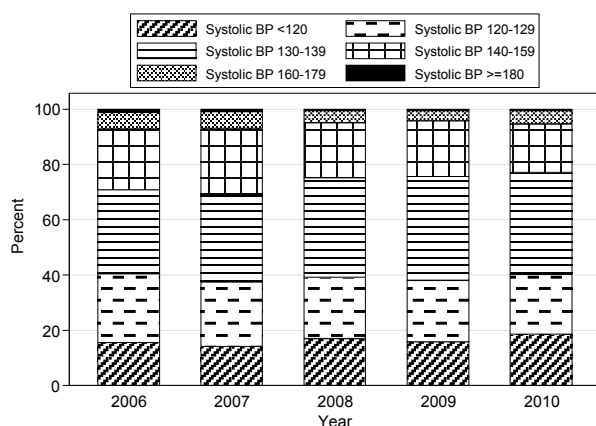
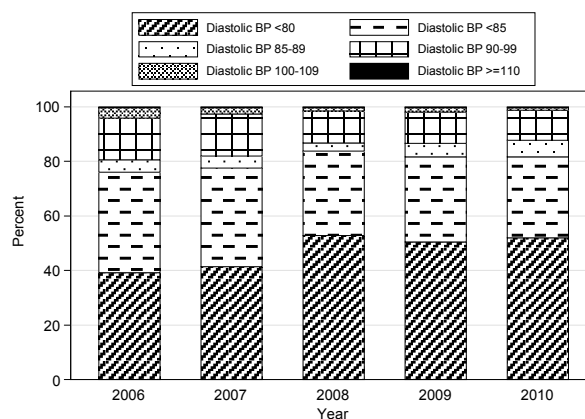


**13.6.2 : Blood Pressure classification according to JNC VI criteria, 2006-2010**

In 2010, 18% of renal transplant recipients had stage I hypertension whereas 5% had stage II hypertension and 0.6% had stage III hypertension despite being on treatment (Table 13.6.2 (a)). In terms of diastolic hypertension 11% had stage I hypertension, 1.1% of patients had stage II diastolic hypertension and 0.22% of patients had stage III diastolic hypertension despite being on treatment (Table 13.6.2 (b)).

**Table 13.6.2(a):** Systolic BP, 2006-2010

Systolic BP (mmHg)	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
<120	249	15.64	240	14.22	289	17.02	269	15.87	331	18.47
120-129	395	24.81	392	23.22	377	22.20	376	22.18	390	21.76
130-139	483	30.34	531	31.46	612	36.04	638	37.64	661	36.89
140-159	353	22.17	409	24.23	335	19.73	340	20.06	314	17.52
160-179	93	5.84	99	5.86	75	4.42	62	3.66	86	4.80
>=180	19	1.19	17	1.01	10	0.59	10	0.59	10	0.56

**Figure 13.6.2(a):** Systolic BP, 2006-2010**Figure 13.6.2(b):** Diastolic BP, 2006-2010**Table 13.6.2(b):** Diastolic BP, 2006-2010

Diastolic BP (mmHg)	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
<80	624	39.20	699	41.41	898	52.89	856	50.50	932	52.01
80-84	586	36.81	610	36.14	525	30.92	528	31.15	533	29.74
85-89	73	4.59	74	4.38	50	2.94	84	4.96	108	6.03
90-99	244	15.33	261	15.46	198	11.66	195	11.50	196	10.94
100-109	61	3.83	39	2.31	22	1.30	27	1.59	19	1.06
>=110	4	0.25	5	0.30	5	0.29	5	0.29	4	0.22

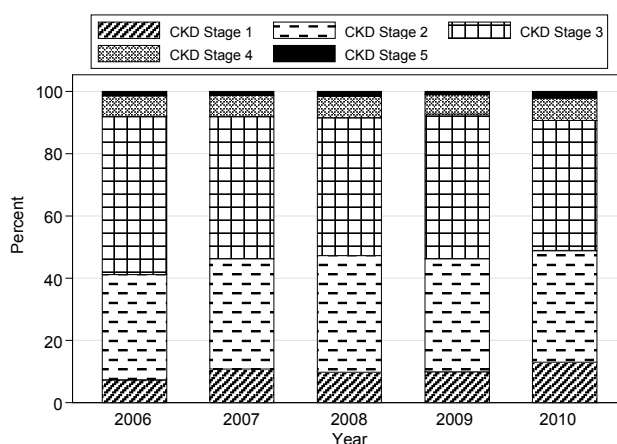
**13.6.3: Level of allograft function**

Table and Figure 13.6.3 shows the CKD Stage classification by year and in 2010, 41.9% of renal transplant recipients had CKD Stage III whilst another 7.1% had CKD Stage IV. CKD Stage V (impending renal replacement therapy) was found in 2.2% of renal transplant recipients.

**Table 13.6.3:** CKD stages, 2006-2010

Year	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
Stage 1	116	7.33	180	10.78	164	9.80	165	9.92	231	13.08
Stage 2	535	33.80	592	35.45	628	37.51	604	36.30	630	35.67
Stage 3	803	50.73	762	45.63	738	44.09	771	46.33	740	41.90
Stage 4	107	6.76	113	6.77	118	7.05	106	6.37	126	7.13
Stage 5	22	1.39	23	1.38	26	1.55	18	1.08	39	2.21

**Figure 13.6.3:** CKD stages by year



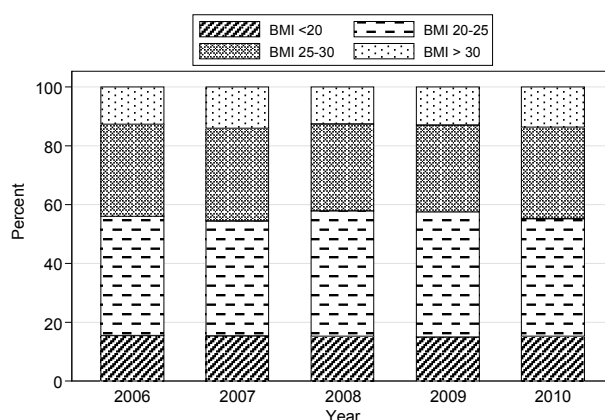
**13.6.4: Body Mass Index**

In 2010, 55.1% of renal transplant recipients had BMIs of 25 or below. However 31.1% were overweight and another 14% were obese. There seems to be a slow but steady increase in numbers of obese patients over the last few years.

**Table 13.6.4:** BMI, 2006-2010

Year	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
<20	246	15.45	259	15.34	257	15.14	253	14.93	273	15.23
20-25	647	40.64	660	39.10	725	42.70	723	42.65	715	39.90
25-30	496	31.16	531	31.46	501	29.51	499	29.44	558	31.14
> 30	203	12.75	238	14.10	215	12.66	220	12.98	246	13.73

**Figure 13.6.4:** BMI, 2006-2010



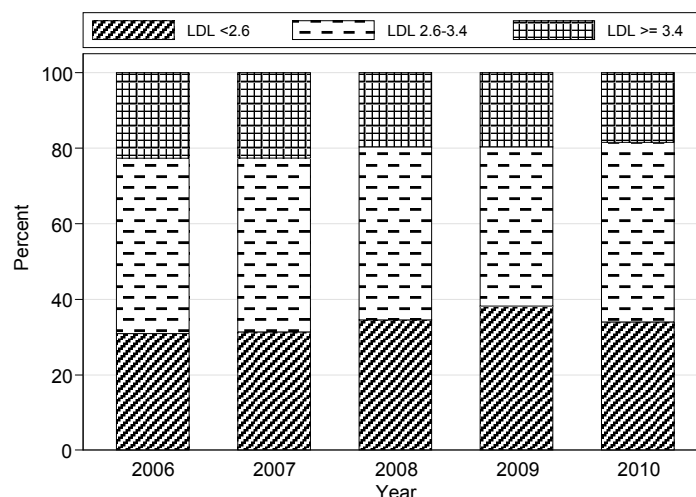
**13.6.5: Lipid profile**

LDL cholesterol has been identified as the primary lipid target for prevention of coronary heart disease by NCEP with a log linear relationship between risk of CHD and level of LDL cholesterol. In terms of renal transplant recipients in 2010, 33.9% have LDL levels below 2.6 mol/l. This has been relatively the same since 2006. Whether or not this translates into less cardiovascular mortality in the transplant population is still questionable. Patients with serum LDL >3.4 also demonstrated downward trend over the last few years.

In terms of other cholesterol parameters for 2010, 44.5% had total cholesterol levels < 5.2 and 7.2% had HDL cholesterol levels <1.0 .

**Table 13.6.5(a): LDL, 2006-2010**

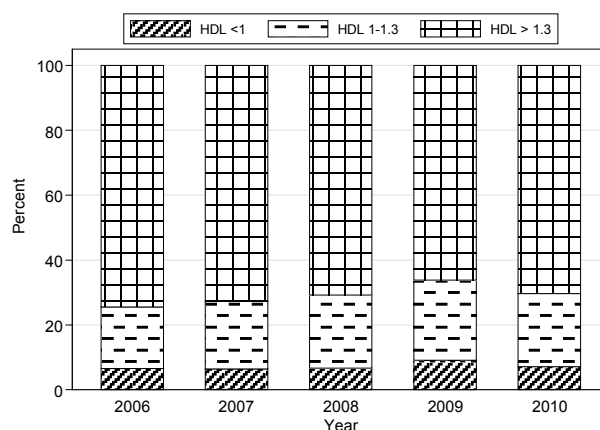
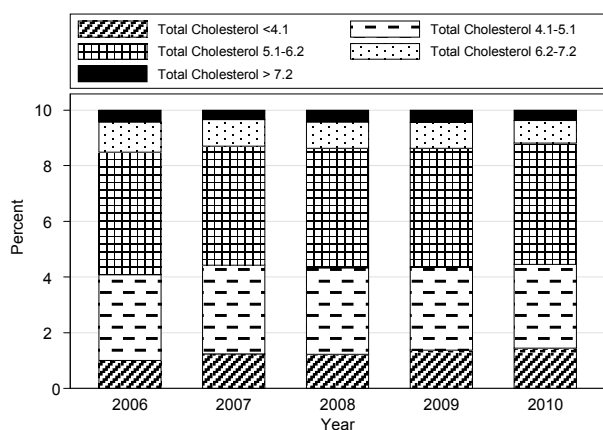
Year	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
< 2.6	492	30.90	528	31.28	586	34.51	648	38.23	608	33.93
2.6-3.4	738	46.36	779	46.15	779	45.88	715	42.18	854	47.66
>= 3.4	362	22.74	381	22.57	333	19.61	332	19.59	330	18.42

**Figure 13.6.5(a): LDL, 2006-2010****Table 13.6.5(b): Total Cholesterol, 2006-2010**

Year	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
<4.1	160	10.05	210	12.44	208	12.25	233	13.75	259	14.45
4.1-5.1	490	30.78	539	31.93	529	31.15	507	29.91	539	30.08
5.1-6.2	700	43.97	721	42.71	728	42.87	721	42.54	783	43.69
6.2- 7.2	173	10.87	159	9.42	160	9.42	159	9.38	144	8.04
> 7.2	69	4.33	59	3.50	73	4.30	75	4.42	67	3.74

**Figure 13.6.5(b): Total Cholesterol, 2006-2010**

**Figure 13.6.5(c): HDL, 2006-2010**



**Table 13.6.5(c): HDL, 2006-2010**

Year	2006		2007		2008		2009		2010	
	n	%	n	%	n	%	n	%	n	%
<1	104	6.53	108	6.40	114	6.71	153	9.03	129	7.20
1-1.3	302	18.97	350	20.73	382	22.50	421	24.84	402	22.43
>1.3	1186	74.50	1230	72.87	1202	70.79	1121	66.14	1261	70.37

**13.6.6: Blood Pressure Control**

In 2010, 82% percent of patients were on antihypertensives and the majority (34%) were on 1 antihypertensive drug, 27% on 2 antihypertensives and 15% on 3 antihypertensives. Six percent of patients still had systolic BP of > 160 mmHg and 13% had diastolic BP of > 90 mmHg despite being given antihypertensive(s), however, this is an improvement from previous years.

**Table 13.6.6(a): Treatment for hypertension, 2006-2010**

Year	n	% on anti-hypertensives	% on 1 anti-hypertensive drug	% on 2 anti-hypertensives	% on 3 anti-hypertensives
2006	1592	86	34	26	17
2007	1688	85	25	31	21
2008	1698	78	25	28	19
2009	1695	81	29	29	17
2010	1792	82	34	27	15

**Table 13.6.6(b): Distribution of Systolic BP without anti-hypertensives, 2006-2010**

Year	n	Mean	SD	Median	LQ	UQ	% Patients ≥ 160mmHg
2006	189	123.8	14.4	120	117	130	4
2007	196	125.2	16.5	120	113	134	4
2008	178	123.7	15.5	120	110	130	3
2009	230	123.9	15.3	120	111	130	3
2010	270	128.7	42.5	123	117	136	4

**Table 13.6.6(c): Distribution of Diastolic BP without anti-hypertensives, 2006-2010**

Year	n	Mean	SD	Median	LQ	UQ	% patients ≥ 90mmHg
2006	189	76.4	10.3	80	70	80	11
2007	196	76.6	10	80	70	80	12
2008	177	75.1	10	80	70	80	10
2009	230	77.4	9.1	80	70	80	12
2010	269	76.9	10.5	80	70	82	16

**Table 13.6.6(d):** Distribution of Systolic BP on anti-hypertensives, 2006-2010

Year	n	Mean	SD	Median	LQ	UQ	% Patients $\geq$ 160mmHg
2006	1334	131.7	16.3	130	120	140	8
2007	1389	132.6	16	130	120	140	8
2008	1269	129.9	16.6	130	120	140	6
2009	1222	131	15.9	130	120	140	5
2010	1317	130.2	16.2	130	120	140	6

**Table 13.6.6(e):** Distribution of Diastolic BP on anti-hypertensives, 2006-2010

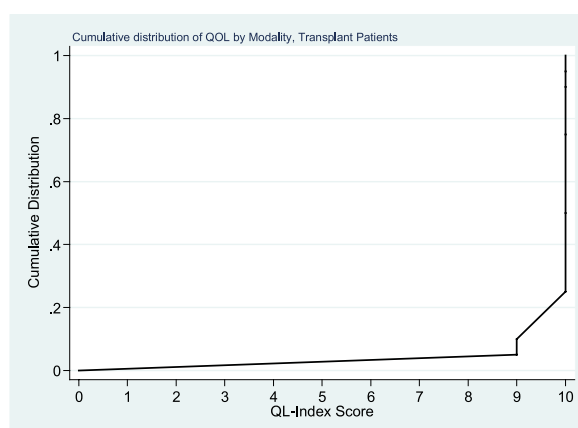
Year	n	Mean	SD	Median	LQ	UQ	% Patients $\geq$ 90 mmHg
2006	1334	79.2	9.9	80	70	86	22
2007	1388	79.1	9.6	80	70	85	20
2008	1255	77.6	10	80	70	80	16
2009	1220	78.3	9.5	80	70	82	16
2010	1313	77.9	21.5	80	70	82	13

## SECTION 13.7: QOL INDEX SCORE IN RENAL TRANSPLANT RECIPIENTS

1249 patients who were transplanted between 2001-2010 were analyzed for QoL index score. They reported median QoL index score of 10 (Table 13.7.1 and Figure 13.7.1). It was interesting to note that for those who underwent renal transplantation between this period, diabetics and non-diabetics had the same median QoL index score of 10 (Table 13.7.2 and Figure 13.7.2), and this is in contrast to HD and CAPD patients where diabetics reported lower QoL index score than non-diabetics. There was also no difference seen between gender (Table 13.7.3 and Figure 13.7.3) and age (Table 13.7.4 and Figure 13.7.4). It is worthwhile to note that those above 60 year-old also enjoyed the same QoL index score (10) as their younger counterpart (Table 13.7.4 and Figure 13.7.4). This trend of high QoL index score among renal transplant patients was maintained over the last 10 years (Table 13.7.5 and Figure 13.7.5).

**Table 13.7.1:** Cumulative distribution of QoL-Index score in relation to Dialysis Modality, Transplant recipient patients 2001-2010

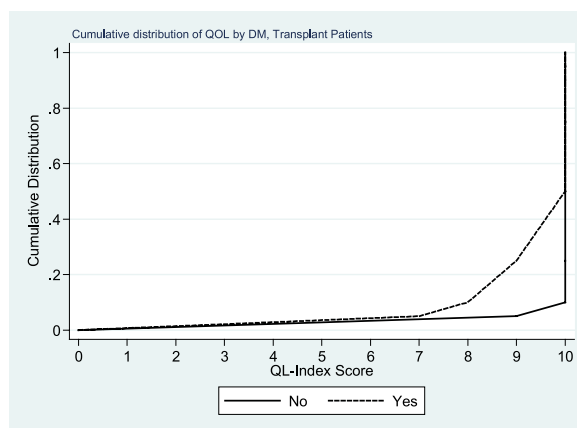
Dialysis modality	QoL score
Number of patients	1249
Centile	
0	0
0.05	9
0.1	9
0.25 (LQ)	10
0.5 (median)	10
0.75 (UQ)	10
0.9	10
0.95	10
1	10

**Figure 13.7.1:** Cumulative distribution of QoL-Index score in relation to Dialysis Modality, Transplant recipient patients 2001-2010

**Table 13.7.2:** Cumulative distribution of QoL-Index score in relation to Diabetes mellitus, Transplant recipient patients 2001-2010

Diabetes mellitus	No	Yes
Number of patients	1194	55
Centile		
0	0	0
0.05	9	7
0.1	10	8
0.25 (LQ)	10	9
0.5 (median)	10	10
0.75 (UQ)	10	10
0.9	10	10
0.95	10	10
1	10	10

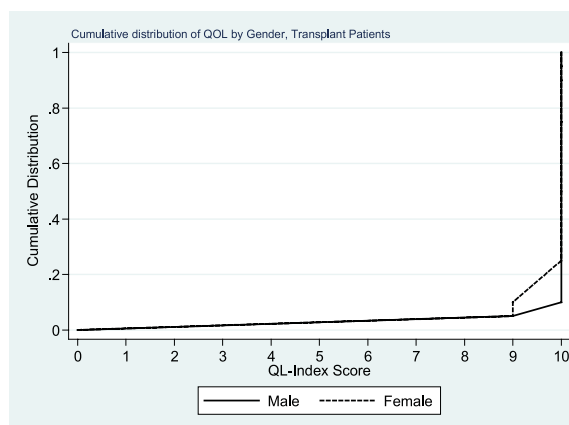
**Figure 13.7.2:** Cumulative distribution of QoL-Index score in relation to Diabetes mellitus, Transplant recipient patients 2001-2010



**Table 13.7.3:** Cumulative distribution of QoL-Index score in relation to Gender, Transplant recipient patients 2001-2010

Gender	Male	Female
Number of patients	783	466
Centile		
0	0	0
0.05	9	9
0.1	10	9
0.25 (LQ)	10	10
0.5 (median)	10	10
0.75 (UQ)	10	10
0.9	10	10
0.95	10	10
1	10	10

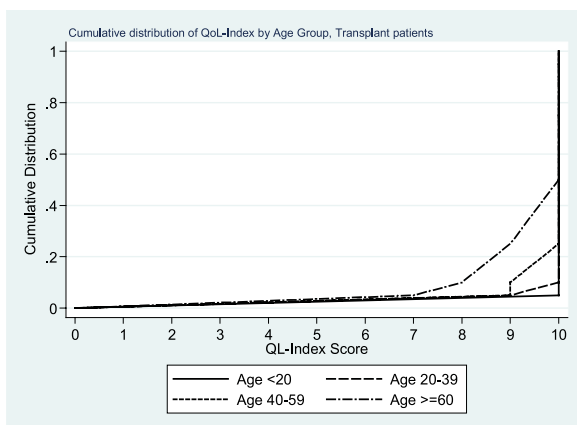
**Figure 13.7.3:** Cumulative distribution of QoL-Index score in relation to Gender, Transplant recipient patients 2001-2010



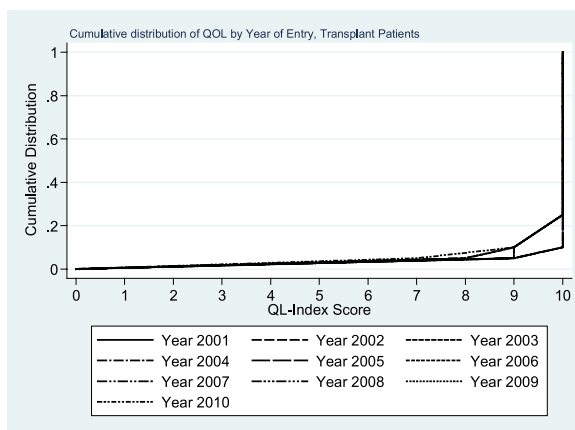
**Table 13.7.4:** Cumulative distribution of QoL-Index score in relation to Age, Transplant recipient patients 2001-2010

Age group (years)	<20	20-39	40-59	>=60
Number of patients	132	480	549	88
Centile				
0	0	0	0	0
0.05	10	9	9	7
0.1	10	10	9	8
0.25 (LQ)	10	10	10	9
0.5 (median)	10	10	10	10
0.75 (UQ)	10	10	10	10
0.9	10	10	10	10
0.95	10	10	10	10
1	10	10	10	10

**Figure 13.7.4:** Cumulative distribution of QoL-Index score in relation to Age, Transplant recipient patients 2001-2010



**Figure 13.7.5:** Cumulative distribution of QoL-Index score in relation to Year of entry, Transplant recipient patients 2001-2010



**Table 13.7.5:** Cumulative distribution of QoL-Index score in relation to Year of entry, Transplant recipient patients 2001-2010

Year of Entry	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Number of patients	127	145	136	168	154	137	95	106	112	69
Centile										
0	0	0	0	0	0	0	0	0	0	0
0.05	9	9	8	9	9	9	8	8	9	7
0.1	9	10	9	9	10	10	9	9	10	9
0.25 (LQ)	10	10	10	10	10	10	10	10	10	10
0.5 (median)	10	10	10	10	10	10	10	10	10	10
0.75 (UQ)	10	10	10	10	10	10	10	10	10	10
0.9	10	10	10	10	10	10	10	10	10	10
0.95	10	10	10	10	10	10	10	10	10	10
1	10	10	10	10	10	10	10	10	10	10





APPENDIX



# **DATA MANAGEMENT**

## APPENDIX 1: DATA MANAGEMENT

### Introduction

Data integrity of a register begins from the data source, data collection tools, data verification and data entry process. Registry data is never as perfect as clinical trial data. Caution should be used when interpreting the results.

### Data source

The initial phase of the data collected in the Malaysian Dialysis and Transplant Registry (MDTR) covered all Renal Replacement Therapy (RRT) patients in the Ministry of Health program since its inception in the early 1970s. The Register subsequently received the data from other sectors of RRT providers like the private, non-government organization (NGO), armed forces and the universities.

MDTR continues to actively ascertain new RRT centres in the country. The mechanism of ascertainment is through feedback from the dialysis related companies, current Source Data Provider (SDP) and public propagandas. This will gradually and eventually result in a complete RRT centre database. The identified RRT centre is invited to participate in data collection.

Participation in the MDTR which was entirely voluntary prior to 2006 is now made compulsory by the Private Health Care Facilities and Services Act 1998 and its Regulations 2006 which was implemented on 1<sup>st</sup> May 2006. This however only applies to private and NGO centres and data submission from centres managed by the Ministry of Health, Defence or the Universities is still voluntary. RRT centres which have expressed interest in participating will be recruited as SDP.

In 2010, there were 589 Haemodialysis centres (HD) known to MDTR (Table I). 45 new centres agreed to participate. 14 centres were found to cease operation either through formal notification or was not contactable during the centre survey exercise.

The Peritoneal dialysis (PD) data were mostly from MOH centres. There are 3 PD centres that had no data submission. These centres had only one or two existing patients that were on follow-up in the clinic. One private PD centre notified that it was not providing further PD treatment.

Renal transplant centre participation in MDTR has shown slight improvement.

**Table I:** Data submission, 2010

	<b>At December Known centres (n)</b>	<b>Agreed to Participate (n)</b>	<b>Submit data (n)</b>	<b>Submit annual returns (n)</b>	<b>2010 Submitted (%)</b>
Haemodialysis	589	587	542	486	92.3
Chronic PD	38	38	35	33	92.11
Transplant	56	56	47	44	83.93
All modality	683	681	579	518	82.67

### Data collection

MDTR is a paper base data submission. The case reporting forms are designed to facilitate the data transcription and the information required are readily available in the patient's case note. All the SDPs are provided with instructions on data collection and submission to the Register. The standard data collection forms are colour coded by modality and case report form (CRF) types. The notification forms are submitted periodically or whenever there is an incident. Annual return forms for the assessment year should reach the NRR coordinating office not later than January the following year. The CRFs are:

- Patient notification form
- Outcome notification form
- HD annual return form
- PD annual return form
- Transplant annual return form
- Work related rehabilitation and quality of life assessment form – annual assessment

MDTR collects patients' demographic details, clinical data, dialysis treatment data, transplant data, peritonitis data and outcome data. MDTR holds individual patient's identifiable data that allow complete follow-up despite patient transfers from one centre to another or change of modality which are especially common among the RRT patients. These patients are monitored and tracked through from the time they were registered until their death. For those patients who were lost to follow-up, MDTR will verify their final outcome with the National Vital Registration System. Patient profiles are submitted to the Register throughout the year. The identity of patients in the database is not released publicly or in the registry reports.

Centre-specific reports are generated and forwarded to SDP on a quarterly basis. This has generated increased feedback from SDP and improved the patient ascertainment rate and the accuracy of the data transmittal in the registry.

MDTR also conducts an annual centre survey on the staffing and facility profile. The survey questionnaire provides summary information about the number of patients on various treatments. This acts as the basis to calculate the patient ascertainment rate.

### **Database System**

The Register initial database was created in DBASE IV in a single computer environment. It was then upgraded to Microsoft Access as a client server application. Currently the NRR data system is a Pentium Xeon 2.33GHz with dual processors, with a total of 8GB RAM memory and 800GB of RAID-5 (Redundant Array of Independent Disks, level 5). In view of high volume of data accumulated throughout these years, capacity ability, performance and security issues of Microsoft Access, it was subsequently migrated to Microsoft SQL Server in the year 2004.

### **Data management personnel**

The data management personnel in the Register office are trained base on the standard operating procedures (SOP). The data entry process is also designed to enhance data quality. Quality assurance procedures are in place at all stages to ensure the quality of data.

### **Visual review, Data entry and de-duplication verification, Data Editing**

On receiving the case report form (CRF) submitted by SDP, visual review is performed to check for obvious error or missing data in the compulsory fields. Data entry will not be performed if a critical variable on the CRF is missing or ambiguous. The CRF is returned to the SDP for verification.

After passing the duplicate check, the data is then entered and coded where required. Edit checks are performed against pre-specified validation rules to detect missing values, out of range values or inconsistent values. Any data discrepancy found is verified against the source CRF and resolved within the Register office where possible. Otherwise the specific data query report will be generated and forwarded to the SDP to clarify and resolve the data discrepancy.

### **Data coding, data cleaning / data analysis**

Most of the data fields have auto data coding. Those data in text fields will be manually coded by the Register manager. A final edit check run is performed to ensure that data is clean. All queries are resolved before dataset is locked and exported to the statistician for analysis

### ***Limitation:***

NRR data submission is still paper base. The majority of the RRT centres do not have electronic patient information system. Computer literacy among staff is still low.

The data submission to the Register is still mainly on voluntary basis using the standard data collection forms. Some SDP choose not to participate in data collection on the patient treatment data for various reasons.

### **Data release and publication policy**

One of the primary objectives of the Registry is to make data available to the renal community. There are published data in the registry's annual report in the website: <http://www.msn.org.my/nrr>. This report is copyrighted. However it may be freely reproduced without the permission of the National Renal Registry. Acknowledgment would be appreciated. Suggested citation is: YN Lim, LM Ong, BL Goh (Eds). Eighteenth Report of the Malaysian Dialysis and Transplant Registry 2010. Kuala Lumpur 2011

A distinction is made between use of NRR results (as presented in NRR published report) and use of NRR data in a publication. The former is ordinary citation of published work. NRR, of course encourages such citation whether in the form of presentation or other write-ups. The latter constitutes original research publication. NRR position is as follows:

The NRR does not envisage independent individual publication based entirely on NRR published results, without further analyses or additional data collection.

NRR however agrees that investigator shall have the right to publish any information or material arising in part out of NRR work. In other words, there must be additional original contribution by the investigator in the work intended for publication.

NRR encourages the use of its data for research purpose. Any proposed publication or presentation (e.g. manuscript, abstract or poster) for submission to journal or scientific meeting that is based in part or entirely on NRR data should be sent to the NRR prior to submission. NRR will undertake to comment on such documents within 4 weeks. Acknowledgement of the source of the data would also be appreciated. Any formal publication of a research based in part or entirely on NRR data in which the input of NRR exceeded that of conventional data management and provision will be considered as a joint publication by investigator and the appropriate NRR personnel.

Any party who wish to request data for a specific purpose that requires computer-run should make such requests in writing (by e-mail, fax, or classic mail) accompanied by a Data Release Application Form and signed Data Release Agreement Form. Such request will require approval by the Advisory Board before the data can be released.

#### **Distribution of report**

The Malaysian Society of Nephrology has made a grant towards the cost of running the registry and the report printing to allow distribution to all members of the association and the source data producers. The report will also be distributed to relevant Health Authorities and international registries.

Further copies of the report can be made available with donation of RM60.00 to defray the cost of printing. The full report is also available in the registry web site [www.msn.org.my/nrr](http://www.msn.org.my/nrr).

APPENDIX ||

# **ANALYSIS SETS, STATISTICAL METHODS AND DEFINITIONS**

**APPENDIX II: ANALYSIS SETS, STATISTICAL METHODS AND DEFINITIONS****Analysis sets**

This refers to the sets of cases whose data are to be included in the analysis.

Six analysis sets were defined:

**1. Dialysis patients notification between 2001 and 2010**

This analysis set consists of patients commencing dialysis between 2001 and 2010. This analysis set was used for the analysis in Chapter 1, 2 and 3.

Patients who were less than 20 years old at the start of dialysis between 2001 and 2010 were used for the analysis in Chapter 5.

Since 1993, the MDTR conducted an annual survey on all dialysis patients to collect data on dialysis and drug treatment, clinical and laboratory measurements. All available data were used to describe the trends in these characteristics. For this analysis in relation to these characteristics, only data from 2001 onwards were used. Remaining missing data in this analysis set was imputed using first available observation carried backward or last observation carried forward. This analysis set was used for the analysis in Chapters 6 to 12. However, the generated variable that has been imputed is prescribed Kt/V for HD patients. Prescribed Kt/V was generated using the formula below:

$$Kt/V = kdx \times hd\_time \times 60 / (0.58 \times post\ weight \times 1000)$$

where

$$kdx = [1 - \exp(-ex)] \times HD\ flow\ rate \times 500 / [500 - HD\ flow\ rate \times \exp(-ex)]$$

and

$$ex = (500 - HD\ flow\ rate) \times ka / (500 \times HD\ flow\ rate).$$

This variable is considered in Chapter 11.

**2. New Dialysis Patients**

The number of new dialysis patients was based on the first dialysis treatment of the patients. Patients who convert from one dialysis modality to another (from HD to PD or vice versa) are not counted as new patients. If transplant is the 1st modality and patient's kidney transplant failed and he received dialysis, then for RRT count, the patients will be counted twice. However, if the patients receive transplant between the dialysis, then the dialysis after transplant will be counted if the transplant last for more than 90 days while if it is less than or equal to 90 days, then the dialysis after the transplant will not be counted. This analysis set definition was used in chapters 1, 2 and 5.

**3. Rehabilitation outcomes**

Analysis is confined to the relevant population. Hence we exclude the following groups.

Age less than or equal to 21 years

Age more than or equal to 55 years

Homemaker

Full time student

Retired

This analysis set was used for the analysis in Chapter 4.

**4. Centre Survey data**

Section 2.2 in the report was based on annual centre survey data between 2001 to 2010 rather than individual patient data reported to the Registry.

**5. Peritonitis data**

Analysis was confined to chronic PD patients who were on peritoneal dialysis from 31<sup>st</sup> December 2000. This analysis set was used for the analysis in Section 12.4.

**6. Renal transplant data**

This analysis set was confined to patients who had undergone renal transplantation from 2001-2010.. This analysis set was used for the analysis in Chapter 13.

**7. Diabetes Mellitus**

Patients are considered to have diabetes mellitus (DM) as the cause of ESRD if the primary cause of ESRD is notified as DM; or as unknown but the comorbid is DM. This is applicable to chapter 2, 3 and 13.

## Statistical methods

### 1. Population treatment rates (new treatment or prevalence rates)

Treatment rate is calculated by the ratio of the count of number of new patients or prevalent patients in a given year to the mid-year population of Malaysia in that year, and expressed in per million-population. Results on distribution of treatment rates by state are also expressed in per million-population in the state since states obviously vary in their population sizes.

### 2. Adjusted Mortality of dialysis patients

Cox proportional hazards model was considered for mortality of the patients adjusted with demographic and laboratory variables. This analysis was used in Chapter 3 and 12.

### 3. Analysis of trend of intermediate results

For summarizing intermediate results like continuous laboratory data, we have calculated summary statistics like mean, standard deviation, median, lower quartile, upper quartile and the cumulative frequency distribution graph is plotted by year. Cumulative distribution plot shows a listing of the sample values of a variable on the X axis and the proportion of the observations less than or greater than each value on the Y axis. An accompanying table gives the Median (50% of values are above or below it), upper quartile (UQ, 25% of values above and 75% below it), lower quartile (LQ, 75% of values above and 25% below it). Other percentiles can be read directly off the cumulative distribution plot. The table also shows percent of observations above or below a target value, or with an interval of values; the target value or interval obviously vary with the type of laboratory data. For example, interval of values for prescribed Kt/V is >1.3 and that for haemoglobin is <10, 10-11 and >11 g/l. The choice of target value is guided by published clinical practice guidelines, for example, the DOQI guideline; or otherwise they represent consensus of the local dialysis community. This analysis was used in Chapter 4, 6, 7, 8, 9, 11 & 12.

### 4. Centre survey data

In contrast to other results reported in this report, Section 2.2 in chapter 2 was based on centre survey data rather than individual patient data reported to the Registry. This is to provide up-to-date information on patient and centre census in the country and thus overcome the inevitable time lag between processing individual patient data and subsequent reporting of results. The survey was conducted in the month of December 2010. Centre response rate to survey was almost 100%. Standard error estimates are not reported because no sample was taken. Results on distribution by state are also expressed in per million state-population since states obviously vary in their population sizes. State population data are based on 2009 census projection. It is very difficult to estimate the amount of cross boundary patient flow; this source of error is therefore not accounted for in computing states estimates. However, we minimize the bias by combining states (eg Kedah and Perlis) based on geographical considerations. HD treatment capacity is derived by assuming on average patients underwent 3 HD sessions per week and a centre can maximally operate 2.5 shifts per day. A single HD machine can therefore support 5 patients' treatment. Obviously HD treatment capacity is calculated only for centre HD. The ratio of the number of centre HD capacity to number of centre HD patient is a useful measure of utilization of available capacity.

### 5. Centre variation

To compare the variation of the intermediate results between centres, graphs describing intermediate results in each centre are presented. The 95% confidence intervals have been calculated using the normal approximation of the Poisson to show the variation of proportion in centres. Lower quartile and upper quartile are instead plotted in comparison of variation in median among centres. An accompanying table gives the summary statistics like minimum, 5th percentile, lower quartile, median, upper quartile, 95th percentile and maximum value among centres over year. Centres with intermediate results for <10 patients were combined into one composite centre. This analytical method was used in Chapter 6, 7, 8, 9, 10 11 & 12.

### 6. Death rate calculation

Annual death rates were calculated by dividing the number of deaths in a year by the estimated mid-year patient population.

### 7. Incidence rate ratio

The incidence rate is determined by dividing the number of new cases of a disease or condition in a specific population over a given period of time by the total population. Therefore incidence rate ratio is the comparison of two groups in terms of incidence rate. Poisson regression model was considered to estimate the independent effect of each factor, expressed as incidence rate ratio. An incidence rate ratio of 3 means 8. that group 2 have the rate 3 times higher than group 1 when group 1 is the reference group.

### 8. Odds ratio

The odds of an event is the probability of having the event divided by the probability of not having it. The odds ratio is used for comparing the odds of 2 groups. If the odds in group 1 is 1 and group 2 is 2, then odds ratio is 1/2. Thus the odds ratio expresses the relative probability that an event will occur when 2 groups are compared.

With multiple factors such as dialysis center, age, sex, modality, albumin, hemoglobin, calcium, cardiovascular and cholesterol, logistic regression model was used to estimate the independent effect of each factor, expressed as odds ratio, on the event of interest and the variation is odds ratio. This method was used in Chapter 3.



### 9. Standardized mortality rate

The cohort considered for this analysis were patients who were on dialysis in 2009 and new patients in 2009 by modality. SMR is a ratio between the observed number of death with the expected, based on the age group, diabetic, serum album group, diastolic blood pressure group and hemoglobin group rates in a standard population and the age group, diabetic, serum album group, diastolic blood pressure group and hemoglobin group distribution of the study population. If the ratio observed : expected death is greater the 1.0, we conclude that there is "excess death" in the study population. SMR was generated using the following formula:

$$\text{SMR} = \text{observed death} / \text{expected death}$$

### 10. Risk adjusted mortality rate (RAMR)

When the mortality rate are risk adjusted, the information beomes more comparable among the hospitals because the data is adjusted to take into account variations in patients' severity of renal disease and their risk of mortality. RAMR was generated using the following formula:

$$\text{RAMR} = \text{SMR} \times \text{AvMR} \text{ where AvMR is the average of the overall observed mortality rate}$$

### 11. Risk ratio

Risk ratio is the relative measure of the difference in risk between the exposed and unexposed populations in a cohort study. The relative risk is defined as the rate of disease among the exposed divided by the rate of the disease among the unexposed. A relative risk of 2, means that the exposed group has twice the disease risk as the unexposed group.

### 12. Survival analysis

The unadjusted survival probabilities were calculated using the Kaplan-Meier method, in which the probability of surviving more than a given time can be estimated for members of a cohort of patients without accounting for the characteristics of the members of that cohort.

In order to estimate the difference in survival of different subgroups of patients within the cohort, a stratified proportional hazards model (Cox) was used where appropriate. The results from Cox model are interpreted using a hazard ratio. Adjusted survival probabilities are adjusted for age, gender, primary diagnosis and time on RRT. For diabetics compared with non-diabetics, for example, the hazard ratio is the ratio of the estimated hazards for diabetics relative to non-diabetics, where the hazard is the risk of dying at time t given that the individual has survived until this time. The underlying assumption of a proportional hazards model is that the ratio remains constant throughout the period under consideration.

Technique failure is defined as occurrence of death or transfer to another modality of dialysis. Similarly, graft failure is defined as occurrence of death or returned to dialysis.

### 13. Patient survival was considered in two ways:

Survival censored for change of modality based on first modality. Duration survival for patients will be calculated from the date commencing the first modality till first modality outcome. Hence duration after the change modality or transplant will not be considered. Death occurring during the first modality will be considered in the analysis since patients will be censored for change of modality before death.

Survival not censored for change of modality based on first modality. Duration survival for patients will be calculated from the date commencing the first modality till 31 Dec 2010 for patients who were still on RRT. For patients who died, duration of survival will be calculated from date commencing the first modality till date of final outcome which is death. All death outcomes whether occurring during first modality or after change in modality will be considered for this analysis.

### 14. Survival of incident patients by centre

#### a. 1-year survival

The cohort considered for this analysis was considered from 2001-2009. Many patients commencing dialysis in 2010 would still not have completed one year.

#### b. 5-year survival

The cohort considered for this analysis was considered from 2001-2005. This is due to those commence from 2005 onwards still not able to have 5 year survivals analysis.

### 15. Funnel plot

This analysis was confined to new dialysis patients from year 2001-2009. The figure is included to assess whether survival probability adjusted to age 60 and diabetes of each centre is likely to be different from the national average. Centres with patients less 10 will be excluded from the analysis. This plot was used in Chapter 3.

### 16. Peritonitis rate

The occurrence of peritonitis is expressed as number of episode per patient-month of observation; peritonitis rate in short. Relapse peritonitis is defined as peritonitis caused by the same organism occurring within 6 weeks of diagnosis of previous peritonitis.

### 17. Cumulative Risk

Cumulative risk of sero-conversion is the cumulative incidence rate of patient being converted from sero-negative to sero-positive over a period of time. It was calculated by the number of cases during a period divided by number of subjects at risk i.e. sero-negative patients at the beginning of time. This analysis was used in chapter 10.

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*Thank You !*

Your data is contributing to a higher  
standard of dialysis care in MALAYSIA