5 years ago we introduced the concept of “Bridges to Innovation” for the China pharma industry

1. **Broad bridge**
   - Mature drugs have lasting staying power and continue to grow beyond 2020
   - China delivers meaningful and broad step-up to reward of innovation

2. **Narrow bridge**
   - Mature drugs have staying power, but come under stronger pressure and plateau beyond 2020
   - China delivers meaningful but narrow reward for innovation, closely aligned with disease priorities

3. **Broken bridge**
   - Window for mature drugs starts closing rapidly by 2020, earlier for some drug categories
   - Innovation remains heavily constrained
   - Self-pay market becomes main viable segment

Each potential scenario will have profound implications on market outlook and attractiveness for participants

It will take some time before we know for sure which bridge we are walking on
As of 2018, we are increasingly confident to say that we are progressing on the "narrow bridge"

1. **Broad bridge**
2. **Narrow bridge**
3. **Broken bridge**

**Uptake of innovation starting to accelerate and showing signs of pivot towards "broad bridge"**

**Mature products come under much stronger pressure in the coming few years - "reckoning time"?**
4 key questions to explore …

1. Impact of Digital and Analytics?
2. Momentum of the innovation drive?
3. Speed of improvement in market access?
4. Macro market evolution?
4 key questions to explore …

<table>
<thead>
<tr>
<th>Macro market evolution?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Momentum of the innovation drive?</td>
</tr>
<tr>
<td>Speed of improvement in market access?</td>
</tr>
<tr>
<td>Impact of Digital and Analytics?</td>
</tr>
</tbody>
</table>
2018 in the mirror...and view from the top

2018 in the mirror

View from the top: GMs outlook for the future
2018 in the mirror – another year of “China speed” development

1. NMPA reform stays the course...for now
2. Broadening of access accelerates
3. Threat to mature brands reaches tipping point
4. China takes center stage for several large MNCs
5. War for talents at boiling point
6. HKEX embraces Biotech
7. China innovation reaches global stage
8. Trade tensions begin...
Besides organizational changes in major healthcare government authorities marked by consolidation of decision making...

<table>
<thead>
<tr>
<th>Key topic</th>
<th>From ...</th>
<th>To ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key topic 1: Sharpening concept of “big health”</td>
<td>[Icons and text]</td>
<td>[Icons and text]</td>
</tr>
<tr>
<td>Key topic 2: Enhanced BMI management</td>
<td>[Icons and text]</td>
<td>[Icons and text]</td>
</tr>
<tr>
<td>Key topic 3: Dedicated drug regulation</td>
<td>[Icons and text]</td>
<td>[Icons and text]</td>
</tr>
</tbody>
</table>

1 Most functions except for NRCMS (New Rural Cooperative Medical system). 2 Function responsible for implementation of “WHO Framework Convention on Tobacco Control” 3 Occupational Safety and Health Supervision Management. 4 URBMI (Urban Resident Basic Medical Insurance) and UEBMI (Urban Employee Basic Medical Insurance). 5 NRCMS (New Rural Cooperative Medical system). 6 Management of medicine and healthcare service prices. 7 Medical Assistance

SOURCE: State Council’s Ministerial Reform Scheme 2018; Press search; McKinsey analysis
The NMPA\(^1\) reform stays the course… for now

Pace of new drug registration and regulatory authority reform not interrupted by recent organizational changes; long term impact remains to be seen

\(\text{(The NMPA) reform used to proceed at a very fast, even radical pace. After all these events, we do not see the reform going backward. Instead, we believe it will continue to take place, but in a more steady and thoughtful way. We are quite positive on that“}

– GM interview

\(^1\) National Medical Products Administration

\(\text{SOURCE: CDE; press search; team analysis}\)
Broadening of Access accelerates

Improved accessibility since 2017 through...

- **128** western drugs were added to the NRDL through direct listing
- **36** of 44 drugs participating in national negotiation got listed on NRDL
- **17** oncology drugs further added to NRDL through negotiation in Q3 2018

- Essential Drug List updated in October, expanding from **520** to **685 molecules**; with high priced & non-NRDL listed drugs included for the first time

- **Cancer drugs** exempted from import taxes starting in May
- Premier Li’s visit to Roche
- Movie “**Dying to Live**” triggered nationwide discussion on access to innovative drugs

National drug negotiation

EDL update

Push from central government
Threat to mature brands reaches tipping point

Mature brands continue to be essential to the performance of leading MNCs...

Revenue breakdown of top 9 MNCs (USD bn)

- >10 yrs since 1st registration
- 5-10 yrs since 1st registration
- <5 yrs since 1st registration

<table>
<thead>
<tr>
<th>Year</th>
<th>&gt;10 yrs</th>
<th>5-10 yrs</th>
<th>&lt;5 yrs</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>14.8</td>
<td>13.7</td>
<td>0.2</td>
<td>18.7</td>
</tr>
<tr>
<td>2017</td>
<td>16.8</td>
<td>15.2</td>
<td>0.3</td>
<td>16.3</td>
</tr>
<tr>
<td>2018 Q1-Q3</td>
<td>15.1</td>
<td>13.0</td>
<td>0.8</td>
<td>18.9</td>
</tr>
</tbody>
</table>

...however, several key facts point to 2019 as potentially being the “year of reckoning”

- Share of brands >10 years since 1st registration:
  - 2016: 93%
  - 2017: 91%
  - 2018 Q1-Q3: 86%

SOURCE: RDPAC; team analysis
GQCE making strides in 2018, albeit with some challenges in implementation roll-out

Long way to go to complete “289 EDL” by end of 2018

18 approvals
# of molecules out of the “289 EDL products” that passed GQCE

68 applications
# of molecules out of the “289 EDL products” under GQCE applications

Fierce competition for selected molecules

~50 companies conducting BE in selected molecules (e.g., Amlodipine, Metformin)

>40 BE studies from leading local companies

Local leaders emerging

SOURCE: GBI; press search; team analysis
China takes center stage for several large MNCs

Leading MNCs restructure their organization with greater China centricity in mind

- **2017 – Relocated Asia Development Center from Singapore to Shanghai**
- **2017 – Promoted China EVP, Leon Wang, to oversee international commercial business from China**
- **2017 – Promoted China GM Xu Dong Yin to lead APMA business**
- **2019 – Reorganizing into three businesses with the leadership team of Established Medicines business based in China**
- **2019 – Building ‘China and emerging market’ new BU**

SOURCE: Annual reports; Press search, team analysis, expert interview
War for talents reaches boiling point – flow of key MNC talents towards local biotechs under way

Transfer of talents from MNCs to Locals is also visible at mid level management, and will particularly impact Development, Medical and Access functions

SOURCE: Annual reports; press search, team analysis
HKEX embraces Biotech

New rules encourage pre-revenue biotech companies to list on HKEX¹ ...

- Biotech companies that do not meet any of the financial eligibility tests of the Main Board
- High-growth and innovative companies with weighted voting right (WVR) structures
- Qualifying issuers seeking a secondary listing on the Exchange

... 10+ biotechs in the queue

- April 24
  - Biotech companies that do not meet any of the financial eligibility tests of the Main Board
  - High-growth and innovative companies with weighted voting right (WVR) structures
  - Qualifying issuers seeking a secondary listing on the Exchange

- August 01
  - ~USD400 mn raised

- August 08
  - ~USD900 mn raised

- September 14
  - ~USD110 mn raised

- October 31
  - ~USD400 mn raised

¹ Hong Kong Exchanges and Clearing Limited

SOURCE: Press search, team analysis
US-Sino trade tensions begin…

Ongoing US-Sino dispute involves more than USD200 billion worth of China and US goods, which are subject to 5-25% additional tariff.

<table>
<thead>
<tr>
<th>First round</th>
<th>US charge on China</th>
<th>China charge on US</th>
</tr>
</thead>
<tbody>
<tr>
<td>818 items incl. medical products¹</td>
<td>USD34 bn (25% tariff)</td>
<td>545 items</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Second round</th>
<th>279 items</th>
<th>USD16 bn (25% tariff)</th>
<th>333 items</th>
<th>USD16 bn (25% tariff)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Third round</td>
<td>Incl. illumination products, consumer goods</td>
<td>USD200 bn (from 10% to 25% by the end of 2018)</td>
<td>5,207 items incl. medical products</td>
<td>USD60 bn (5-10% tariff)</td>
</tr>
</tbody>
</table>

---

¹ 1,122 out of 1,300 separate tariff lines involving biomedical products, 32 lines on medicinal chemicals, 38 on drugs or biological products, 52 on medical devices and related products.

SOURCE: Ministry of Commerce of the People's Republic of China; office of United States Trade Representative; Press research.
2018 in the mirror…and view from the top

2018 in the mirror

View from the top: GMs outlook for the future
We interviewed and surveyed GMs of most leading MNCs in China

Companies interviewed

- AstraZeneca
- Baxter
- Bayer
- Boehringer Ingelheim
- Bristol-Myers Squibb
- GSK
- Lilly
- Lundbeck
- Merck
- MSD
- Novartis
- Pfizer
- Roche
- Servier
- Sanofi
- UCB

Structured GM survey
5 key predictions for the next 3 years

01: Importance of China market likely to remain steady, driven by growing innovative business but offset by pressure on mature products.

02: Talent war for biopharma companies is underway with continuing expansion of China’s pharma market and boom of innovation ecosystem.

03: Companies, especially MNCs, march toward innovative assets driven portfolio; however, aggressive reimbursement negotiation may erode value of innovation.

04: GQCE and reimbursement reform exert pricing pressure on OPO\(^1\) products, creating more funding for innovation and overall shifting China toward a developed market profile.

05: Digitalization has yet to fundamentally transform industry; however, digital touch points become an essential pillar for customer engagement.

1 Off patent originator
Elevation of China market likely to remain steady with mixed views in shift in portfolio mix

<table>
<thead>
<tr>
<th>China scale vs. global</th>
<th>Innovative vs. off patent contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declining importance</td>
<td>Largely OPO</td>
</tr>
<tr>
<td>Increasing importance</td>
<td>Innovation driven</td>
</tr>
</tbody>
</table>

Strategic importance of China will continue to elevate, e.g., becoming 1st wave of global launch ... portfolio mix in China will shift

Global contribution will likely continue to grow, but facing significant pressure for the mature products

MNCs can aspire to have 50% or more of their portfolio in innovative assets

Contribution of innovative products will continue to grow even though it takes time for the new products to ramp up

SOURCE: McKinsey 2018 Pharma MNC GM Survey
2. GQCE and reimbursement reform exert pricing pressure on OPO products, shifting China toward a developed market profile

<table>
<thead>
<tr>
<th>GQCE scope</th>
<th>Tendering and reimbursement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Limited</td>
<td>Limited centralized procurement</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GQCE scope</th>
<th>Tendering and reimbursement</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Expanding</td>
<td>Expanding centralized procurement</td>
</tr>
</tbody>
</table>

**GQCE scope likely to expand though overall GQCE progress expected to be delayed**

- GQCE is on top of mind for people; we expect to see OSD and IV for sure, but not biosimilars in next 3 years
- GQCE progress likely delayed given current status; Local manufacturers may face challenges in meeting GQCE quality bar

**Gx passing GQCE certification exerting pricing pressure on OPO products**

- Current 4+7 policy will push MNCs out of the market, which will be detrimental for China pharma industry. We expect government to make further changes along the way
- QCE is a good thing for China. But it will bring unprecedented challenge to MNCs

SOURCE: McKinsey 2018 Pharma MNC GM Survey
Companies marching toward innovative assets focused portfolio but value of innovation may diminish with aggressive reimbursement negotiation

**Speed of innovation continues to increases due to sustained NMPA reform**

- **Access will continue to improve, though shadowed by increasing price pressure**

**Areas of focus for future NMPA reform**

- Narrowing: 1
- Broadening: 7

**NRDL update**

- Infrequent: 1
- Dynamic: 7

---

**It’s the right time for innovative drugs to enter China with improvement and globalization of registration process and patent protection**

**Innovation will remain as the priority for NMPA reform, and we expect broadening of reform area to further support innovation**

**Access will improve, especially for innovative drugs, but price pressure will also increase with reimbursement negotiation. Given China’s scale in the global market, China prices will also have global implications**

**Innovation could be commoditized due to reimbursement price cut. Price cut does not have a good basis now, but we have Taiwan, Korea as reference countries. In a few years, China will be wave 1 launch country without reference price**

---

SOURCE: McKinsey 2018 Pharma MNC GM Survey
Acute talent war expected with continuing expansion of China’s pharma market and booming innovation ecosystem

Talent pool for pharma industry in the near future

Limited 1

7 Sufficient

With new products entering market and reimbursement reform, market access and medical affairs talents are in high demand

Healthcare right now needs senior management level talent. We needed scientists before, but now we need senior management talent, to translate science to assets

Talents are also being hunted by local biotech, and new MNCs entering the market, both for senior position and on the ground sales reps

SOURCE: McKinsey 2018 Pharma MNC GM Survey
5 Digital touch points to become an essential pillar for customer engagement and commercial activities

Digital touchpoint complements traditional F2F interaction with physicians, deepening and expanding engagement channel

Growing hope for AI and big data even though transformation still in exploration

Share of digital touch points

1
Limited

7
Essential

4.8

Role and application of AI and big data

1
Limited

7
Transformational

3.9

We will do a lot more digital and remote education to drive better ROI of coverage. Companies will be forced to find more efficient ways to engage customers. More segment focused

I hope digitalization can fundamentally change business models and how companies operate. If we could push both from global and local market, things will accelerate

If we count future WeChat based interactions, then the share of digital interactions will reach significant levels

Digital application will continue to grow given price pressure and cost of FTEs

SOURCE: McKinsey 2018 Pharma MNC GM Survey
4 key questions to explore …

1. Impact of Digital and Analytics?
2. Momentum of the innovation drive?
3. Speed of improvement in market access?
4. Macro market evolution?
Momentum of China biopharma innovation – two topics

Fresh view of China biopharma innovation ecosystem

Momentum of China biotech
To gauge progress of China biopharma innovation ecosystem, we have updated our China Drug Innovation Index (CDII)

**Approach:** CDII survey in collaboration with BayHelix Group

- CDII was first initiated in 2015, followed by a second edition in 2016
- 2018 is the 3rd edition, providing the latest view on China biopharma innovation progress

Assess China innovation ecosystem along 5 dimensions

- Policy environment, Funding, Capability/infrastructure, Local innovation output, Integration into global
- **Calibrated against current U.S. levels** (US = 8 out of 10 points)

Survey of 109 industry experts:

- 73% are CEOs/senior executives
- 63% with 15+ years of industry experiences

*We also appreciate generous support from several industry groups including SABPA, DIA, etc.*
"Fast and slow" evolution of China biopharma innovation ecosystem – 2018 vs. 2015

**Key takeaways**

- **A** Policy environment
  - Significant growth in healthcare investment since 2015, with 2018 growth slowing down
  - HKEX shaping up as new financing channel and exit option for biotechs / investors
- **B** Funding for start-ups
  - R&D capabilities gradually improving, still significant gap vs. US
  - Local innovative pipeline rapidly growing and start to reach commercial stage; clear opportunity to increase differentiation
- **C** Capabilities
  - Reform has made transformative progress (e.g., accelerating review and approval) and continues to catalyze biopharma innovation in China
  - Reimbursement for innovative drugs improving; however clear gaps remain
- **D** Local innovation
  - In-licensing a key venue for Chinese biopharmacos to rapidly expand pipeline
  - China increasingly attracting global talent
- **E** Integration with global

---

1 CDII overall average score across all metrics
2 China 2015 average score has been updated by using only the comparable measures that are tested in 2018 (e.g., the score of mature-co's access to funding is not included)

SOURCE: 2015, 2018 CDII Survey (n=109); McKinsey analysis
Transformative impact of China regulatory reform over past 3 years broadly recognized

Effectiveness of drug review/approval process

Q: Rate progress of CFDA reform since July 2015 on 0-100 scale (100 being: CFDA reform covers most pain points and are effectively carried out, addressed key issues in regulatory environment)

Overall rating on China regulatory reform

Score distribution

- Rating >85: 18%
- Rating 60-85: 68%
- Rating <=60: 14%

A lot of real progress has been made to accelerate development (e.g., CTA approval time, priority review, global data for local registration)

As policies have evolved so fast, still not sure how some of them will be implemented, need more clarity to better understand and react

1 CDII overall average score across all metrics

SOURCE: 2015, 2018 CDII Survey (n=109); China leading biotech CEO interviews; McKinsey analysis
Among regulatory reform’s key changes, review acceleration, joining ICH, and rationalizing clinical trial data requirement ranked with highest impact.

Which regulatory reform actions have created biggest impact in fostering China biopharma innovation?

<table>
<thead>
<tr>
<th>% of agreement</th>
<th>Small molecule</th>
<th>Large molecule</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Review timeline acceleration</strong></td>
<td>25</td>
<td>9</td>
</tr>
<tr>
<td><strong>Joining ICH</strong></td>
<td>70</td>
<td>39</td>
</tr>
<tr>
<td><strong>Rationalizing clinical trial data requirement</strong> (accepting IMCT data for NDA)</td>
<td>66</td>
<td>22</td>
</tr>
<tr>
<td><strong>Marketing Authorization Holder (MAH) pilot program</strong></td>
<td>39</td>
<td>8</td>
</tr>
<tr>
<td><strong>Allowing participation in Phase I IMCT</strong></td>
<td>25</td>
<td>3</td>
</tr>
<tr>
<td><strong>New accelerated review mechanism</strong> (conditional approval, clinically urgent drug list)</td>
<td>14</td>
<td>3</td>
</tr>
</tbody>
</table>

CTA approval timeline, Months

<table>
<thead>
<tr>
<th>Year</th>
<th>Small molecule</th>
<th>Large molecule</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>25</td>
<td>22</td>
</tr>
<tr>
<td>2018</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Future</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

-64% decrease
-62% decrease

1 Pivotal IMCT study can be used for NDA in China - data demonstrating efficacy and safety equivalence in Chinese patients required
2 Based on the CTA approvals for innovative assets, defined as Chem 1 (or Chem 1.1), Chem 5.1 (or Chem Unknown), or Bio 1 (or Bio Unknown) drug class
3 As of 31st Oct, 2018
4 First wave of notification-based CTA released Nov 2018

SOURCE: GBI; CFDA; 2018 CDII Survey (n=109); McKinsey analysis
### POLICY ENVIRONMENT

#### A Priority review has become a key channel for accelerated drug review and approval

<table>
<thead>
<tr>
<th># of applications with priority review¹</th>
<th># of molecules with priority review by TA¹</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supplementary</strong></td>
<td><strong>Examples</strong></td>
</tr>
<tr>
<td>CTA</td>
<td></td>
</tr>
<tr>
<td>NDA</td>
<td></td>
</tr>
</tbody>
</table>

- A total of 194 innovative molecules granted priority review in 33 batches
- 56% of innovative asset NDA approvals in 2018¹ have benefited from priority review (vs. 17% in 2016)
- Nov 2018, CDE announced to further accelerate the priority review listing by immediately review upon receipt

---

1 As of October 31st, 2018, include innovative molecules only (based on the application reference number, where X is classified as innovative molecule); excluding TCM
2 One molecule might have multiple number of applications, and might filed for both CTA and NDA in multiple years
3 Other TAs include respiratory, sensory, musculo-skeletal, dermatology, systemic hormones, genito-urinary, and various
4 Including 25 molecules for rare diseases

---

SOURCE: CDE; McKinsey analysis
A series of new policies enacted in 2018 to further accelerate NDA timeline for drugs addressing urgent clinical need

- **Qualified drug candidate must be in urgent clinical need and:**
  - Be an orphan drug approved outside of China
  - Or have promising early-stage clinical trial data or indicative surrogate endpoints in clinical trials
- **New launches already enjoyed benefits from conditional approval:**
  - Select drugs that are approved in US, EU or Japan could go through special CDE review channel and finish technical evaluation in:
    - **3 months** for orphan drugs
    - **6 months** for other drugs
  - NMPA has encouraged the 48 drugs on the “List” to apply for this channel

### List of 48 drugs eligible for priority review published

- **Rare disease**
  - 24 products
- **Oncology**
  - 12 products
- **Immunology**
  - 6 products
- **Anti-infectives**
  - 4 products
- **CVS**
  - 2 products

### New CTA approval mechanism implemented

- With latest amendment to clinical trial review process, CTA is approved if NMPA does not respond within **60 working days** of filing
- Examples of 1st batch approved CTAs under this new mechanism include:
  - **MSD**
    - MK-7264
  - **Harbour Biomed**
    - HBM9161
  - **Idorsia**
    - Aprocitentan
  - **AbbVie**
    - Adalimumab
  - **Sagacity**
    - SC1011

### Conditional approval granted

- **Dec 2017**
- **Aug 2018**
- **Nov 2018**

**SOURCE:** Literature research; GBI; McKinsey analysis

---

**POLICY ENVIRONMENT**
Looking ahead, majority of the respondents remain confident on direction of regulatory reform in the next 3 years

>85% survey participants remain confident on mid-to-long term prospects of reform

Q: Which of the following statement on the 3-year outlook of regulatory reform resonates most with you?

**Confident** that reform is progressing towards goals in next 2-3 years, and don’t anticipate significant uncertainties in near-term

- 26%

**Confident** about mid-to-long term track, with some short-term uncertainties

- 60%

**Not confident** that the reform will keep on the original track in the mid-long term

- 14%

**Regulatory reform policies in China are becoming more targeted and effective, in both drug approval and post-launch regulations. I think joining the ICH will further help China adopt international regulatory practices. In the long run it will bring more opportunities to drug companies.**

**No doubt that the reform will continue, despite some short term uncertainties – not necessarily headwind for industry, actually giving some time to better adjust and implement.**

1 100 defined as: CFDA reform has covered most of the pain points in the industry today, and are effectively carried out to solve key issues in the regulatory environment

SOURCE: 2018 CDII Survey (n=109); China leading biotech CEO interviews; McKinsey analysis
While some encouraging progress has been made, market access remains an uncertainty for biopharmacos.

Effectiveness of pricing, payment and reimbursement policies

- NRDL updated in 2017, 8 years after the previous round of update
- National Negotiations – ~50 innovative drugs in total were invited to 2 negotiations and most were successfully added to NRDL
- Single national payor – State Medical Insurance Administration was set up in May 2018
- Emergence of private payors like Ping An, Taikang, and MNC insurance companies

...yet questions remain around coverage of public insurance, provincial implementation, and economic implications

- How quickly can new drugs be included?
- What kind of innovative drugs are more likely to be reimbursed?
- How will provincial authorities implement reimbursement updates? (e.g., hospital expense cap, oncology drugs out of stock in many hospitals)
- What are the economic implications to innovative pharmacos?
### FUNDING FOR BIOTECHS

**Improved funding environment for start-ups, especially from VC and PE funds**

**China Biotech’s access to funding**

**Level of ease for Chinese biotechs to finance through following channels?**

(1 = most difficult; 10 = easiest)

- **Government funds**
- **Debt financing**
- **VC**
- **PE**
- **PharmaCo’s strategic investment**
- **Stock market financing**

**China 2015 average = 4.6**

**China 2018 average = 5.4**

**VC and PE investments have seen significant surge while other sources have stayed on par**

1 CDII overall average score across all metrics  
2 VC and PE tested as a combined metric in 2015, thus counted once in the avg. score  
3 Metrics not tested in 2015

**SOURCE:** 2015, 2018 CDII Survey (n=109); McKinsey analysis
Despite slowdown in fundraising in 2018, investment in healthcare still on a high-growth track

China VC/PE funds raised targeting healthcare

<table>
<thead>
<tr>
<th>Year</th>
<th># of funds</th>
<th>Funding USD bn</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>29</td>
<td>0.6</td>
</tr>
<tr>
<td>2014</td>
<td>48</td>
<td>3.9</td>
</tr>
<tr>
<td>2015</td>
<td>86</td>
<td>10.9</td>
</tr>
<tr>
<td>2016</td>
<td>46</td>
<td>20.2</td>
</tr>
<tr>
<td>2017</td>
<td>74</td>
<td>39.8</td>
</tr>
<tr>
<td>2018 H1</td>
<td>30</td>
<td>13.8</td>
</tr>
</tbody>
</table>

VC/PE investment in China healthcare

<table>
<thead>
<tr>
<th>Year</th>
<th># of deals</th>
<th>Funding USD bn</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>42</td>
<td>0.8</td>
</tr>
<tr>
<td>2014</td>
<td>64</td>
<td>1.7</td>
</tr>
<tr>
<td>2015</td>
<td>62</td>
<td>1.8</td>
</tr>
<tr>
<td>2016</td>
<td>267</td>
<td>7.8</td>
</tr>
<tr>
<td>2017</td>
<td>478</td>
<td>12.7</td>
</tr>
<tr>
<td>2018 H1</td>
<td>396</td>
<td>10.3</td>
</tr>
</tbody>
</table>
A wave of IPOs by China biotechs over past 3 years, with more lining up

Notable IPOs in recent years

- **2015.6**: Junshi Biosciences
  - Listed on NEEQ in 2015; submitted prospectus to list on HKEX

- **2016.11**: Betta Pharma
  - Raised USD106M

- **2017.3**: Beyond Spring
  - Raised USD54M

- **2017.6**: WuXi Biologics
  - Raised USD511M

- **2017.9**: Zai Lab
  - Raised USD150M

- **2018.8**: Ascletis Pharma
  - Raised USD400M

- **2018.8**: BeiGene
  - Raised USD760M (also listed on NASDAQ in 2016)

- **2018.9**: Hua Medicine
  - Raised USD110M

- **2018.10**: Innovent
  - Raised USD400M

Potential near term IPOs (submitted prospectus to list on HKEX unless otherwise mentioned)

- **MicuRx**: Biotech company focusing on antimicrobial therapeutics
- **Frontage**: Full service CRO
- **Cansino Bio**: Vaccines company
- **Ascentage**: Focusing on apoptosis, targeted small mol. therapeutics
- **Viva Biotech**: Drug discovery platform
- **Hansoh Pharma**: China biopharma focusing on Oncology, Psychotropic, Antidiabetic, etc.

1 National Equities Exchange and Quotations; 2 Shenzhen Stock Exchange; 3 Hong Kong Stock Exchange

SOURCE: Company websites; Nasdaq; Bloomberg; press search
**FUNDING FOR BIOTECHS**

HKEX seen as an important emerging financing channel for biotechs, yet it will take time to mature

<table>
<thead>
<tr>
<th>Statement</th>
<th>Level of agreement to each statement (percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HKEX’s position</strong></td>
<td></td>
</tr>
<tr>
<td><em>Today</em>, it is already one of the preferred financing channels for innovative Chinese biopharma companies</td>
<td><img src="image1" alt="62%" /> <img src="image2" alt="44%" /> <img src="image3" alt="18%" /></td>
</tr>
<tr>
<td><em>In 3 years</em>, it will become one of the preferred financing channels</td>
<td><img src="image4" alt="52%" /> <img src="image5" alt="41%" /> <img src="image6" alt="11%" /></td>
</tr>
<tr>
<td><strong>Assessment of biotechs listed on or in process of filing for HKEX</strong></td>
<td></td>
</tr>
<tr>
<td>They can well <strong>represent</strong> China’s biopharma innovation</td>
<td><img src="image7" alt="35%" /> <img src="image8" alt="26%" /> <img src="image9" alt="9%" /></td>
</tr>
<tr>
<td>Their <strong>stock performance</strong> can reflect intrinsic business value</td>
<td><img src="image10" alt="33%" /> <img src="image11" alt="29%" /> <img src="image12" alt="4%" /></td>
</tr>
<tr>
<td>Their innovation is at the <strong>equivalent level of innovation</strong> to companies listed in the US</td>
<td><img src="image13" alt="15%" /> <img src="image14" alt="13%" /> <img src="image15" alt="2%" /></td>
</tr>
</tbody>
</table>

**Key takeaways**

- Majority of industry experts remain optimistic on outlook of HKEX in becoming one of preferred financing channels for biotechs
- Going forward more emphasis put on quality of biotechs’ assets (e.g., addressing meaningful unmet needs, high differentiation)
- In addition, more specialized investor expertise needed (e.g., equity analyst with deep biotech expertise) to conduct evidence-based rigorous value assessment

*SOURCE: 2018 CDII Survey (n=109); team analysis*
Despite rapid development in other areas, China still lacks high-quality talents to support sustainable biopharma innovation.

Quality of R&D talents

<table>
<thead>
<tr>
<th>Academic Research</th>
<th>Drug discovery</th>
<th>Clinical development</th>
<th>CMC</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015=4.3</td>
<td>2015=4.7</td>
<td>2015=5.0</td>
<td>2015=5.0</td>
</tr>
<tr>
<td>2018=4.9</td>
<td>2018=4.9</td>
<td>2018=5.0</td>
<td>2018=5.6</td>
</tr>
</tbody>
</table>

China 2015 avg. = 4.8
China 2018 avg. = 5.0

1 CDII overall average score across all metrics
2 Academic Research was not tested in 2015 CDII survey

SOURCE: 2015, 2018 CDII Survey (n=109 in 2018); team analysis
Novelty of innovative assets still lagging; quality of R&Ds has clear room to grow

Still very few true innovation in China. The only recent example is the Ebola vaccine

Clinical development capability and capacity is a key pain point for whole industry, especially for early stage

Hard to catch up with the U.S. in the next 5 years, as they have invested much more into R&D activities and have materially better fundamental research capabilities

1 CDII overall average score across all metrics  
2 Metrics not tested in 2015  
3 Average of ‘Novelty of innovative pipeline’ and the average ‘Quality of R&D’ scores

SOURCE: 2015, 2018 CDII Survey (n=109); China leading biotech CEO interviews; McKinsey analysis
Growing number of local innovative assets have progressed towards commercialization

**# of innovative assets** from local pharmacos, **# of molecules**

<table>
<thead>
<tr>
<th>Stage</th>
<th>Small molecules</th>
<th>Biologics</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>70</td>
<td>26</td>
</tr>
<tr>
<td>2018</td>
<td>88 (+8%)</td>
<td>68 (+38%)</td>
</tr>
</tbody>
</table>

- **Discovery**
  - Innovative CTA filing
- **Clinical development**
  - Innovative NDA filing
- **NDA**
  - Innovative NDA approval
- **Commercialization**

**CAGR '15-'18**
- xx%

SOURCE: GBI; CFDA; McKinsey analysis

1 Innovative assets include Chem 1 (and Chem 1.1) and Bio 1 class molecules
2 As of 31st Oct, 2018
Local biopharma innovations are facing several challenges

MNCs’ innovative drugs are getting to China market faster than ever (recent examples)

“Herding” phenomena in few areas such as Oncology, leading to fierce competition

Regulatory reform has significantly shortened the gap between global first launch and China approval for MNC pharmacos

<table>
<thead>
<tr>
<th>Brand name</th>
<th>TA</th>
<th>Launch lag, years</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAGRISSO® oximertinib</td>
<td>Oncology</td>
<td>1.4</td>
</tr>
<tr>
<td>ZEPATIER®</td>
<td>Anti-infective</td>
<td>1.4</td>
</tr>
<tr>
<td>EPCLUSA</td>
<td>Anti-infective</td>
<td>1.9</td>
</tr>
<tr>
<td>Entresto® (valsartan/hydrochlorothiazide tablets)</td>
<td>CVS</td>
<td>2.1</td>
</tr>
<tr>
<td>NINLARO</td>
<td>Oncology</td>
<td>2.4</td>
</tr>
<tr>
<td>Praxbind® (oxacillin sodium)</td>
<td>Blood</td>
<td>2.6</td>
</tr>
<tr>
<td>Viekirax® (daclatasvir/dasabuvir)</td>
<td>Anti-infective</td>
<td>2.7</td>
</tr>
<tr>
<td>Exviera®</td>
<td>Anti-infective</td>
<td>2.7</td>
</tr>
<tr>
<td>Repatha® (evolocumab)</td>
<td>CVS</td>
<td>2.9</td>
</tr>
<tr>
<td>OFEV®</td>
<td>Respiratory</td>
<td>2.9</td>
</tr>
<tr>
<td>Trumeq®</td>
<td>Anti-infective</td>
<td>2.9</td>
</tr>
</tbody>
</table>

# of innovative assets\(^2\) under development by local pharmacos in 2018

<table>
<thead>
<tr>
<th>Brand name</th>
<th>TA</th>
<th>Num.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovent IBI188</td>
<td>Oncology</td>
<td>36 (61%)</td>
</tr>
<tr>
<td>CS3006</td>
<td>CNS</td>
<td>8</td>
</tr>
<tr>
<td>CAN017</td>
<td>CV</td>
<td>6</td>
</tr>
<tr>
<td>GB235</td>
<td>Others</td>
<td>4</td>
</tr>
<tr>
<td>HG146</td>
<td>Anti-infectives</td>
<td>3</td>
</tr>
<tr>
<td>CD19</td>
<td>Alimentary</td>
<td>2</td>
</tr>
<tr>
<td>CAR-T</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Based on the time difference between global first launch and China NDA approval
2 An innovative asset is defined as Chem 1 and Bio 1 drug class

SOURCE: GBI; CFDA; EvaluatePharma; Press search; McKinsey analysis
Recognizing intensifying competitions, industry experts anticipate clear shift towards more differentiated innovations

China biopharma NMEs have skewed towards me-too/me-better innovation to date

Looking ahead, industry experts expect clear shift towards more innovative portfolio

Which type of innovation should China biopharmacos focus on …

<table>
<thead>
<tr>
<th>% of agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakthrough (first in class)</td>
</tr>
<tr>
<td>“First to China” in areas with significant unmet needs</td>
</tr>
<tr>
<td>Balanced mix of incremental and breakthrough</td>
</tr>
<tr>
<td>Incremental (Me-too/me-better)</td>
</tr>
</tbody>
</table>

Examples of local biopharma innovations by MoA

<table>
<thead>
<tr>
<th>Small molecule</th>
<th>Large molecule &amp; new modalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>GK1 (Dorzagliatin)</td>
<td>Ad5-EBOV (recombinant Ebola virus vaccine)</td>
</tr>
<tr>
<td>IDH1 (Ivosidenib)</td>
<td>FGFR2b (Bemarituzumab)</td>
</tr>
<tr>
<td>FGF and VEG (Brivanib)</td>
<td></td>
</tr>
<tr>
<td>EGFR TKI (BPI-7711, HS-10296, Neptinib, ES-072)</td>
<td>PD-1/PD-L1 (SHR-1210, CS1001, GB226)</td>
</tr>
<tr>
<td>DPP-4 (Besiglaptin, Retaglaptin, Imiglaptin, Uloglaptin)</td>
<td>PCSK9 (SHR-1209, IBI306, AK102)</td>
</tr>
<tr>
<td>PARP (Fluzoparib, Mefuparib, IMP4297)</td>
<td>VEGF (Conbercept, Affecizx)</td>
</tr>
</tbody>
</table>

1 Glucokinase

SOURCE: GBI; Press search; McKinsey analysis
Cross-border collaboration shows accelerated momentum, especially in in-licensing from global sources.

### Contribution to Global Innovation

- **China out-license to global partner**
- **China in-license from global partner**
- **China’s ability in attracting/retaining global talent**

---

**Table: Cross-border licensing deals**

<table>
<thead>
<tr>
<th>Year</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>76</td>
</tr>
<tr>
<td>2015</td>
<td>66</td>
</tr>
<tr>
<td>2016</td>
<td>76</td>
</tr>
<tr>
<td>2017</td>
<td>96</td>
</tr>
<tr>
<td>2018 H1</td>
<td>64</td>
</tr>
</tbody>
</table>

---

1. CDII overall average score across all metrics
2. Cross-border contribution tested as a combined metric in 2015

SOURCE: 2015, 2018 CDII Survey (n=109); ChinaBio 2018 Report; McKinsey analysis

**Graph Details:**
- **China 2015**
  - Contribution to global innovation score = 3.6
  - China out-license to global partner = 3.9
  - China in-license from global partner = 5.8
- **China 2018**
  - Average score = 5.2
  - In-license from global partner = 5.8

**Assumed US**
- 2015 = 4.0
- 2018 = 5.0
**China companies continue to actively leverage cross border deals to enrich pipeline and gain access to additional capital**

**Breakdown of major licensing deals by asset origin, # of assets**

<table>
<thead>
<tr>
<th>China to global</th>
<th>China from global</th>
</tr>
</thead>
<tbody>
<tr>
<td>38</td>
<td>35</td>
</tr>
</tbody>
</table>

2017 | 2018 Oct¹

<table>
<thead>
<tr>
<th>Henlius</th>
<th>HLX02</th>
</tr>
</thead>
<tbody>
<tr>
<td>accord</td>
<td>accord</td>
</tr>
<tr>
<td>ARCURIS</td>
<td>Pharmaceutical Company</td>
</tr>
<tr>
<td>TG Therapeutics</td>
<td></td>
</tr>
<tr>
<td>agios</td>
<td>TIBSOVO®</td>
</tr>
<tr>
<td>NOVARTIS</td>
<td>FGF401</td>
</tr>
<tr>
<td>NOVARTIS</td>
<td></td>
</tr>
<tr>
<td>Karyopharm</td>
<td>Selinexor, Eltanexor, Verdinexor, KPT-9274</td>
</tr>
<tr>
<td>REMD BIOATHERAPEUTICS</td>
<td>REMD-288, REMD-290</td>
</tr>
<tr>
<td>ENTASIS THERAPEUTICS</td>
<td>ETX2514</td>
</tr>
</tbody>
</table>

**Selected highlights of 2018 licensing deals**

- **Cross-board collaboration** becoming one of the **key sources of China innovative pipelines**
- A **significant surge of licensing deals in 2018 by 47%** compared to 2017
- **China companies start to export innovation**, though not yet reaching the scale of in-licensing

¹ As of 2018/10/31

**SOURCE:** GBI; Press search; McKinsey analysis
China funds have been active overseas; however, future momentum could be overshadowed by looming Sino-US trade tension.

As the Sino-US trade conflict escalates, you will expect…

- Fewer in-licensing deals from US to China\(^1\)
- Other markets (e.g., Europe) more favored by investors\(^1\)
- Researchers and talent exchange less active\(^2\)

\(^1\) Include responses from CEO/Founder, Senior mgmt./investor and Middle mgmt./investor (n=93)
\(^2\) Include responses from CEO/Founder, Senior mgmt./investor and scholars (n=86)

SOURCE: 2018 CDII Survey (n=109); team analysis
In summary...

- Regulatory environment
- Investment into biotech
- Cross-boarder licensing deals

Rapid progress made in “bright spots”

Opportunities ahead

- Shaping market access policies to properly reward innovation
- Continue to enhance R&D capabilities and elevate innovation, building on promising momentum
Momentum of China biopharma innovation – two topics

Fresh view of China biopharma innovation ecosystem

Momentum of China biotech
2018 is another banner year for China biotech financing in terms of total investment amount and growing scale of financing rounds.

Total funding raised by biotech has skyrocketed\(^1\)

<table>
<thead>
<tr>
<th>Deal value</th>
<th>USD bn</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>0.5</td>
</tr>
<tr>
<td>2016</td>
<td>1.1</td>
</tr>
<tr>
<td>2017</td>
<td>1.5</td>
</tr>
<tr>
<td>2018</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Selected top deals in 2018:

- **Brii Biosciences**: USD260m in initial funding round.
- **CStone**: USD260m in series B.
- **I-Mab**: USD220m in series C, largest series C in China.
- **Innovent**: USD150m in series E.
- **Henlius**: USD157m in series B.
- **Yisheng Pharmaceutical**: USD150m in series C.

New records set in 2018 for biotech fundraising, including Brii Biosciences (USD260m in initial round), CStone (USD260m in series B), and I-Mab (USD220m in series C), etc.

1 Includes China-based biotech companies only and does not include traditional pharma companies with innovation pipelines. Data as of Oct 2018.

SOURCE: IT Juzi (included companies with publicly disclosed funding activities); team analysis.
China biotechs have raised USD2.3 bn publicly since 2016, with more companies lining up for IPO

Biotech IPO boom started in 2016 (Unit: USD mn)

- BeiGene (NASDAQ) IPO: 160 mn
- zaiLab. (NASDAQ) IPO: 175 mn
- BeiGene (HKEX dual-listing) IPO: 900 mn
- Innoven (HKEX) IPO: 400 mn
- 5+ companies have filed for IPO
- BeiGene's market cap for NASDAQ and HKEX
- BeiGene's fund raised on HKEX
- Chi-Med's market cap for LSE and NASDAQ
- Many have announced IPO plans

...coming years

1 Represents BeiGene’s fund raised on HKEX
2 Represents BeiGene’s market cap for NASDAQ and HKEX
3 Represents Chi-Med’s market cap for LSE and NASDAQ

SOURCE: Bloomberg, press releases

McKinsey & Company
In addition, China investments have poured into U.S. biotechs, however going forward trade tension might create headwind.

**Chinese investors’ growing interest in western biotechs**

*Investment wave backed by strong momentum*

- Greater government backing for biotech innovation as part of “Made in China 2025”
- Improving China regulatory environment making China market attractive to western biotechs

**Headwind from a deepening China-U.S. trade rift**

- CFIUS\(^2\) reviewing foreign investments for national security concerns
- Increased tariff limiting China’s exports; although biotech has not been targeted thus far

---

**DVC deals completed in the U.S. USD bn**

<table>
<thead>
<tr>
<th>Year</th>
<th>Jan-Sept</th>
<th>Global ex. China investors</th>
<th>Non-China investor participation</th>
<th>China investors participation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>3.3</td>
<td>3.6</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>2016</td>
<td>3.5</td>
<td>3.6</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>2017</td>
<td>4.5</td>
<td>4.5</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>2018</td>
<td>7.3</td>
<td>4.7</td>
<td>2.6</td>
<td>2.6</td>
</tr>
</tbody>
</table>

**Share of investment with Chinese investors’ participation**

- 2015: 7%
- 2016: 4%
- 2017: 23%
- 2018: 36%

---

1 Investment per year categorized by biotech deal completion date. China investors represents deals with Chinese investor participation, not total investments made by China investors.
2 Committee on Foreign Investment in the United States

SOURCE: Pitchbook as of Q3 2018. 2018 data represents January to September 2018
Size of innovative pipeline developed by local players continues to expand, with heavy focus on oncology

**Innovative** assets approved for CTA by local players, **# of molecules**

- **Oncology**
- **Anti-infectives**
- **Blood**
- **Alimentary**
- **CNS**
- **Others**

**Oncology assets** approved for CTA by MoAs, **# of molecules**

- **PD-1/PD-L1**
- **EGFR**
- **ADC**
- **PI3K**
- **HER-2**
- **PARP**
- **CDK4/6**
- **VEGF**
- **Others**

**Share of oncology asset, %**

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018 Oct</th>
</tr>
</thead>
<tbody>
<tr>
<td>34</td>
<td>52</td>
<td>48</td>
<td>61</td>
<td></td>
</tr>
</tbody>
</table>

1 Innovative assets are defined as Chem 1 (or 1.1 for 2007 classification) and Bio 1 drugs
2 Other TAs including: systemic hormones, sensory, musculo-skeletal, CVS, dermatology, respiratory, various, and undisclosed TAs
3 Based on WHO ATC classification where L01 (and some of L02/03) is defined as oncology
4 Based on the total number of CTAs approved by molecules from 2017 to 2018 Oct
5 Other MoAs including: c-MET, MEK, CAR-T, CD47, CDK9, HDAC, Topo I, ALK, Bcl-2/Bcl-XL, OX40, Src, MDM2, BTK, EpCAM/CD3, CD20, mTOR, NOD2, IL12, uPA, IAP, IDO, HER-3, and undisclosed MoAs

**SOURCE:** GBI; CFDA; Press search; Team analysis
Leading China biotechs have reached commercial stage, with more to come

~20 innovative assets\(^1\) have filed NDA in 2018\(^2\), including:

**PD-1s**
- JS001
- Sintilimab
- Camrelizumab
- Tislelizumab

**Protein Kinase Inhibitors**
- Flumatinib
- Avitinib
- Zanubrutinib

1 Defined as Chem 1 and Bio 1 drug class
2 As of 2018/10/25

SOURCE: GBI; Press search; Company websites; McKinsey analysis
While committed to establishing strong foothold in China, leading China biotechs showing aspiration to capture global market

Phase II/III innovative assets developed by Chinese companies¹

Multi-regional clinical trial conducted to reach global market

**BeiGene**

23+ trials for 5 assets
Including US, UK, France, Italy, Australia, Japan, and Korea

**Ascantage Pharma**

5+ trials for 3 assets
Including US and Australia

**Henlius**

2+ trials for 1 asset
Including US, Taiwan, and Singapore

**Alphamab**

1+ trials
Including US, Australia, and New Zealand

---

1 Company headquarters located in China, data based on estimation in Pharmaprojects as of Oct. 31st, 2018

SOURCE: PharmaProjects; Clinicaltrials.gov; Press search; Company websites; McKinsey analysis
China biotechs are taking two approaches to address meaningful unmet needs of patients in China and beyond

**Significant unmet medical needs in China and beyond**

- Diseases have not been eradicated or are without appropriate medical solutions
- Affordability barriers hindering broad adoption of innovative therapies

**China biotechs’ two innovation approaches**

**Leapfrog approach**
- Focus on developing first-in-class/best in class MOA in areas with significant unmet medical needs worldwide

**Step-wise approach**
- Start with me-too/me better assets to build up team’s R&D capabilities, broadening Chinese patients’ access to innovative therapies; overtime expand to FIC/BIC
Two types of unmet needs

High and growing disease burden in China

<table>
<thead>
<tr>
<th>Disease</th>
<th>2015</th>
<th>2030</th>
<th>15-30 CAGR, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVD prevalence, Mn</td>
<td>263</td>
<td>345</td>
<td>2.7%</td>
</tr>
<tr>
<td>Diabetes prevalence, Mn</td>
<td>106</td>
<td>131</td>
<td>1.5%</td>
</tr>
<tr>
<td>All cancer incidence, Mn</td>
<td>4</td>
<td>6</td>
<td>2.6%</td>
</tr>
</tbody>
</table>

High-value oncology drugs available as targeted therapy choices

NRDL negotiation

Before

Each patient’s out-of-pocket cost per year treatment:

\(~150-200K\) RMB

% of household could afford the treatment:

Less than \(~10\%\)

After

\(~40-60K\) RMB

Up to \(~30-40\%\)

1 Including chemical/biologics oncology drugs
2 Take into account of PAP (Patient Assistance Program)
3 Assume 30% of household income spends on healthcare

SOURCE: WHO; Institute for Health Metrics and Evaluation; press search; Literature search
Many China biotechs share several characteristics:

01. Scaled and risk-balanced portfolio

02. Unraveled speed to establish lead

03. Experimenting with innovative business model
### China biotechs have relative scaled portfolio compared to global peers

#### # of assets\(^1\) by companies when filed IPO in HKEX in 2018

<table>
<thead>
<tr>
<th>Company</th>
<th>Pre-clinical</th>
<th>Clinical</th>
<th>NDA filed/launched</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovent</td>
<td>8</td>
<td>9</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>CanSinoBIO</td>
<td>6</td>
<td>8</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>BeiGene</td>
<td>9</td>
<td>3</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Ascentage Pharma</td>
<td>1</td>
<td>7</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>ascelis</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>MicuRx</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>8</td>
</tr>
</tbody>
</table>

#### # of assets\(^1\) by companies when IPOed in Nasdaq in 2018\(^2\)

<table>
<thead>
<tr>
<th>Company</th>
<th>Pre-clinical</th>
<th>Clinical</th>
<th>NDA filed/launched</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innoven</td>
<td>1</td>
<td>6</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>CanSinoBIO</td>
<td>5</td>
<td>2</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>ARMO BIOSCIENCES</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Entasis</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Vaccinex</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Surface Oncology</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>BioXcel</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Genprex</td>
<td>1</td>
<td>1</td>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>

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1. Assets at all stages and all kind of right (e.g., licensed-in assets with region right) listed in the IPO prospectus; number of combo therapies are not included.
2. Based on IPOs in Nasdaq capital market and global market as of 2018/09/25, and biotech company classification based on Capital IQ classification.

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**“Our portfolio play is a way to stand out in fierce competition. If we follow the traditional US biotech path, we will not be able to leapfrog.”**

– CEO of leading China-based biotechs

**“We have a strategy to license-in relative late stage assets and develop early stage assets in house to ensure we build our pipeline with scale and momentum.”**

– CEO of leading China-based biotechs

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**SOURCE:** GBI database; press search; China leading Biotech CEO interviews; team analysis
China-based biotechs have been actively tapping into in-licensing opportunities to expand portfolio

**Selected in-licensed deals in 2018**

<table>
<thead>
<tr>
<th>In-licensor</th>
<th>Asset</th>
<th>TA/MOA</th>
<th>Deal size(^1) USD mn</th>
<th>Out-licensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avapritinib</td>
<td>Oncology (Gastric) /KIT and PDGFR(\alpha)</td>
<td>~346</td>
<td>blueprint</td>
<td></td>
</tr>
<tr>
<td>BLU-554</td>
<td>Oncology (HCC) /FGFR4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BLU-667</td>
<td>Oncology (NSCLC) /RET</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ivosidenib</td>
<td>IDH1m R/R AML/ IDH1</td>
<td>~412</td>
<td>agios</td>
<td></td>
</tr>
<tr>
<td>BeiGene</td>
<td>Sitravatinib</td>
<td>Oncology/Kinase inhibitor</td>
<td>~123</td>
<td>MIRATI Therapeutics</td>
</tr>
<tr>
<td>VNRX-5133</td>
<td>Anti-infectious /broad-spectrum inhibitor of β-lactamases</td>
<td>~114</td>
<td>VenatorX Pharmaceuticals</td>
<td></td>
</tr>
<tr>
<td>Eravacycline</td>
<td>Anti-infectious /Fluorocycline</td>
<td>~37</td>
<td>TETRA PHASE Pharmaceuticals</td>
<td></td>
</tr>
<tr>
<td>Toca 511/ Toca FC</td>
<td>Oncology/retroviral replicating vector + 5-FC</td>
<td>~111</td>
<td>Tocagen</td>
<td></td>
</tr>
<tr>
<td>ETX2514</td>
<td>Anti-infectious/broad-spectrum inhibitor of β-lactamases</td>
<td>~91</td>
<td>Entasis Therapeutics</td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) Including upfront cash payment, potential milestone payments related to development, regulatory, and sales-based milestones.

SOURCE: GBI database; press search; team analysis
China biotechs are racing against the clock, as evidenced by their funding speed and size

**Fast speed of development exemplified by recent biotech funding activities**

**SOURCE:** Company websites, news release.
China biotechs are experimenting with a range of business models

- R&D strategy includes in-license assets into China
- Targeting to achieve “best-in-class”
- Quickly bring assets to commercialization with
  - In-house drug discovery and manufacturing capabilities
  - Bring innovation to global markets

- Patient-centric service model, paired with differentiated assets
  - Highly differentiated portfolio
  - Leverage digital and big data (e.g., Ali Health) capabilities in R&D and commercialization

- Vertically integrated model, with self-innovation capabilities
  - In-licensing model, flexing for differentiation
  - First-in-class only
  - Acquire global rights for differentiated assets

- Acquire global rights to develop and commercialize assets from MNCs
- Focus on less crowded disease areas

- Start with first-in-class drug candidates
- Conducting clinical trials in China and abroad
Top of mind questions for China biotech CEOs

**Reimbursement**
- How quickly will reimbursement policies evolve to properly reward innovation? What types of innovative therapies will get reimbursed?

**Quality**
- How to ensure high quality in clinical development while progressing multiple trials at rapid pace?

**Talents**
- What is the solution to find quality talent to sufficiently support demand in clinical development and commercialization?

**Competition**
- How to create sustainable differentiation? Will it come from shift towards FIC/BIC assets, differentiated clinical strategy or creative commercial model?

*SOURCE: China leading biotech CEO interviews*
The industry is experiencing a significant talent shortage that is expected to persist in next 2-3 years, and calls for industry-wide solution

**Number of TA physicians**

<table>
<thead>
<tr>
<th>Supply</th>
<th>Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>800-1,000</td>
<td>1,300-1,600</td>
</tr>
</tbody>
</table>

**Potential solutions**

- **Bringing oversea TA physicians with experience and know-how**
  - Potential challenges include language barrier and interaction with local KOLs

- **Accelerate training of local talent**
  - For example, companies can provide rigorous training curriculum on clinical trial practice, and rotation talents across trial phases to build individual capability

- **Industry-wide training program**
  - In collaboration with academic institutions (e.g., Shenyang Pharmaceutical University and China Pharmaceutical University)

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*We have seen that the salaries of TA physicians and clinical operations have increased faster than other functions in China pharma industry in recent 2 years… around 25-40% of salary increase when moving to the next position with the same title

  – HR of leading China based-biotechs

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1 Estimated based on the number of clinical trial growth with optimal TA physicians/trial ratio breakdown by innovative vs. generic drugs

SOURCE: Expert interviews
Looking into the crystal ball – what is the 3-5 year future of China biotech industry?

Positive momentum continues: Expect significant progress on the overall innovation level, yet still with major gap compared to the US

Funding cycle expected: Investment will likely be more cautious before a bounce back as we witness the failures and success of early pipelines

Market will tell: Market will be the gold standard for biotech pioneers and the China innovation model (step wise approach, license in arbitrage, etc.) as part of building a healthy industry

Emerging global presence: A handful of companies and assets will reach global stage
Looking into the crystal ball – food for thoughts for China biotechs

Focus on addressing unmet needs that matter, with evolving view of treatment landscape

Maintain a global standard and prepare for global stage

Embed commercial and market savviness in your organization early on

Double-down in accessing and originating highly differentiated innovation

Invest in fostering organization health and culture as a new competitive advantage

Think partnership across value chain - commercialization and beyond

SOURCE: China leading biotech CEO interviews; McKinsey analysis
4 key questions to explore …

01 Macro market evolution?

02 Momentum of the innovation drive?

03 Speed of improvement in market access?

04 Impact of Digital and Analytics?
Mature brands continue to be a key driver of performance for many large MNC pharmacones

Revenue of top 10 mature brands\(^1\) in past 4 years

USD mn

CAGR 2014-18

Top 10 mature brands added USD2.8 bn since 2014, growing at 16% CAGR on average

Despite increasing pressure on mature brands, performance remains strong, carried by volume expansion

1 Ranked based on revenue from 2017
2 Estimated based on RDPAC 18Q3 data

SOURCE: Industry associations
At the same time, selected new launches appear to gain faster adoption from the “get go”

**Uptake of top launches**

1. Product reaching >100 Mn USD in revenue by 2018
2. Launch year based on first sales data from RDPAC
3. Estimated based on RDPAC 18Q3 data

**SOURCE:** Industry associations

- 4 products launched since 2014 have reached 100 Mn USD within 3 years
- Products in self-pay market with acute needs (e.g., oncology and Vx) show highest potential for accelerated uptake
- Ramp-up of primary care drugs remains heavily constrained
In this context of evolving access environment, two key questions for the biopharma industry

1. Do we believe that access is expanding fast enough to support the wave of ~100 innovative drugs hitting the market since 2016, in addition to those included in NRDL?

2. Do we believe 2019 will be the year of the “reckoning” for mature brands given convergence of new procurement rules, pricing pressure and GQCE roll-out?
2018 witnessed continuation of launch momentum for MNCs as well as local biotechs with ~100 new drugs approved since 2016

**# of new drug approvals** in the past 3 years

<table>
<thead>
<tr>
<th>Year</th>
<th># of MNC Products</th>
<th># of Local Products</th>
<th>Total Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>3</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>2017</td>
<td>17</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>2018 Jan-Sep</td>
<td>30</td>
<td>41</td>
<td>71</td>
</tr>
</tbody>
</table>

**Examples**

Local:
- 艾可宁 (Albuvirtide)
- 乐复能 (Recombinant cytokine gene derived protein)
- 福可维 (Anlotinib)
- 戈诺卫 (Danoprevir)
- 派益生 (Recombinant consensus interferon variant)

MNC:
- 艾瑞妮 (Pyrotinib)
- 爱优特 (Fruquintinib)

SOURCE: GBI; McKinsey analysis

1 CFDA registration approval for innovative drugs, defined as new chemical entity or biologics
Wave of lower price setting for innovative oncology drug in China post NRDL negotiation

Prices of 17 oncology drugs post 2018 NRDL negotiation

Price-cut level for negotiated drugs, %

<table>
<thead>
<tr>
<th>Drug</th>
<th>Hematological malignancies</th>
<th>Solid tumors</th>
<th>NSCLC</th>
<th>RCC²</th>
<th>Gastro-intestinal³</th>
<th>Melanoma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tasigna</td>
<td>-68%</td>
<td>-67%</td>
<td>-45%</td>
<td>-71%</td>
<td>-67%</td>
<td>-46%</td>
</tr>
<tr>
<td>Imbruvica</td>
<td>-65%</td>
<td>-61%</td>
<td>-39%</td>
<td>-71%</td>
<td>-67%</td>
<td>-46%</td>
</tr>
<tr>
<td>Vidaza</td>
<td>-60%</td>
<td>-60%</td>
<td></td>
<td>-71%</td>
<td>-67%</td>
<td>-46%</td>
</tr>
<tr>
<td>Ninlaro</td>
<td>-46%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-46%</td>
</tr>
<tr>
<td>Ai Yang</td>
<td>-40%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-46%</td>
</tr>
<tr>
<td>Tagrisso</td>
<td></td>
<td></td>
<td>-60%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xalkori</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zykdia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fu Ke Wei</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Giotrif</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inlyta</td>
<td></td>
<td></td>
<td></td>
<td>-69%</td>
<td></td>
<td>-46%</td>
</tr>
<tr>
<td>Sutent</td>
<td></td>
<td></td>
<td></td>
<td>-67%</td>
<td></td>
<td>-46%</td>
</tr>
<tr>
<td>Votrient</td>
<td></td>
<td></td>
<td></td>
<td>-65%</td>
<td></td>
<td>-46%</td>
</tr>
<tr>
<td>Erbitux</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-46%</td>
</tr>
<tr>
<td>Stivarga</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-46%</td>
</tr>
<tr>
<td>Sandostatin</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-46%</td>
</tr>
<tr>
<td>Zelboraf</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-46%</td>
</tr>
</tbody>
</table>

Most imported drugs in 2018 NRDL negotiation came out with a price significantly lower than neighboring countries, 36% lower on average

SOURCE: CPA; press search; McKinsey analysis
Despite sharp price cut, robust growth observed at aggregate level fueled by strong volume uptake

- 128 molecules listed in NRDL for the first time
  - *E.g.* Ilaprazole, Alogliptin
- 36 drugs newly listed through price negotiation
  - *E.g.*, Erlotinib, Rituximab
- 8 drugs did not reach agreement with government during negotiation
  - *E.g.*, Infliximab

**Quarterly sales in CPA covered hospitals**

**Average price index\(^2\) change**

<table>
<thead>
<tr>
<th>TTM QoQ sales value growth(^1), %</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRDL direct listing</td>
</tr>
<tr>
<td>Successful negotiation</td>
</tr>
<tr>
<td>Unsuccessful negotiation</td>
</tr>
</tbody>
</table>

1 Based on quarter over quarter growth by using trailing-twelve-month (TTM) calculation
2 Assuming price at 2017Q1 was 100, price is calculated based on the average hospital procurement price in the sample hospitals
3 Based on the timeline of first batch of 19 provinces implemented 2017 NRDL at provincial level from Sep 1\(^{st}\) onwards

**SOURCE:** CPA
Volume growth of successful negotiation drugs mainly comes from lower tier cities and innovative drugs

Patients in lower-tier cities show higher price sensitivity compared to top-tier cities

NRDL listing has significant impact on improving innovative oncology drug accessibility and affordability

1 Based on quarter over quarter growth by using trailing-twelve-month (TTM) calculation
2 Based on sales from 1,041 CPA covered sample hospitals in 31 provinces
3 $\Delta$ is calculated based on the change in growth rate from 2017Q1 to 2018Q1
4 Based on the city tier classification system by McKinsey Global Institute

SOURCE: CPA; McKinsey Global Institute; team analysis
2017 NRDL national negotiation is on track for local implementation

Implementation timeline
- By December 2017, all 31 provinces had included negotiated drugs under PRDL list B

Local reimbursement
- 14 provinces set up OOP from 20% to 50%
- Rest of provinces allowed city/county gov’t to set OOP by their own
- Guangzhou and Beijing also offer coverage for outpatient reimbursement

Clinical use
- 12+ provinces (i.e. Guangdong, Tianjin, Chongqing) removed restriction of drug sales ratio for negotiated drugs
- Strong supervision to ensure rational prescription in line with indication restriction for reimbursement

Procurement
- Negotiated drugs are eligible for direct online procurement in most regions (e.g. Shaanxi, Anhui, Jilin)

SOURCE: Literature research; PDB Database; McKinsey analysis
## Inclusion on NRDL leads to robust uptake of products

**2017 NRDL update included 182 additional drugs**

### Many of those show robust uptake post NRDL inclusion

<table>
<thead>
<tr>
<th>Total revenue USD mn$^3$</th>
<th>-5% p.a.</th>
<th>+31% p.a.</th>
<th>-22% p.a.</th>
<th>+72% p.a.</th>
<th>+5% p.a.</th>
<th>+12% p.a.</th>
<th>+17% p.a.</th>
<th>+30% p.a.</th>
<th>+35% p.a.</th>
<th>+74% p.a.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>47</td>
<td>63</td>
<td>146</td>
<td>171</td>
<td>47</td>
<td>63</td>
<td>146</td>
<td>171</td>
<td>47</td>
<td>63</td>
</tr>
<tr>
<td>2017</td>
<td>17</td>
<td>17</td>
<td>175</td>
<td>184</td>
<td>17</td>
<td>17</td>
<td>175</td>
<td>184</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>2018</td>
<td>221</td>
<td>206</td>
<td>346</td>
<td>365</td>
<td>476</td>
<td>476</td>
<td>346</td>
<td>365</td>
<td>476</td>
<td>476</td>
</tr>
</tbody>
</table>

- **Originators:** 70 out of 159 newly added drugs are originators, 31 of which entered NRDL through national negotiation

1 Not including TCM; 2 Estimated based on RDPAC 18Q3 data; 3. Exchange Rate: 1 USD = 7.03 RMB

**SOURCE:** RDPAC; NRDL

**EXAMPLE**

- **Herceptin** trastuzumab
- **AVASTIN** bevacizumab
- **gleevec** imatinib mesylate
- **Symbicort** (budesonide/formoterol fumarate dihydrochloride/vinyl acetate copolymer)
- **Januvia** (sitagliptin)
First EDL update since 2012, with many target therapies/ non-NRDL listed drugs included, revealing authorities’ priority shifting toward clinical value

<table>
<thead>
<tr>
<th># of drugs included in EDL</th>
<th>Highlight of newly added drugs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2012 EDL</strong></td>
<td><strong>2018 EDL</strong></td>
</tr>
<tr>
<td>TCM</td>
<td></td>
</tr>
<tr>
<td>520</td>
<td>685</td>
</tr>
<tr>
<td>203</td>
<td>268</td>
</tr>
<tr>
<td>Western Medicine</td>
<td></td>
</tr>
<tr>
<td>317</td>
<td>417</td>
</tr>
</tbody>
</table>

- **Targeted therapies included**: 12 oncology drugs listed, incl. 6 TKIs
- **Better aligned with disease burden**: CVS and Metabolic drugs count for 25% of all newly added drugs
- **Non-NRDL listed drugs included**: 11 drugs not reimbursable currently were picked up

- 187 newly added drugs
- 22 drugs removed

SOURCE: National Health Commission
Recent policy surges in accelerating approval of drugs for rare diseases; albeit with limited progress on access

**Policy Highlights (Non-exhaustive)**

- **Support the rare diseases drugs development by reducing and exempting clinical trials**
- **Accelerate approval of innovative treatments, including orphan drugs that have been approved outside China**
- **Encourage the generic drug development for rare disease**
- **Strengthen the guidance on rare disease drugs priority review and using oversea clinical trail information for NDA**
- **Conditional acceptance of overseas clinical trial data for rare disease drug NDA**

**Legislative department:**
Establish a basic law and supporting system for drugs review and approval

**Five joint departments:**
1. The first national rare disease list includes 121 rare diseases
2. 48 drugs already approved in U.S., EU or Japan and could be eligible for direct NDA priority review in China, including 22 drugs for rare disease
3. Extension of ‘the list of overseas drugs in urgent need’ from 48 drugs to selected innovative drugs launched in the past 10 years

**SOURCE:** Literature search; team analysis

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1 NMPA (National Medical Products Administration), former CFDA
2 NHC (National Health Commission), former NHFPC
3 NMIA (National Medical Insurance Administration)
4 National Health Commission of PRC, Ministry of Science and Technology, Ministry of Industry and Information Technology, State Drug Administration, and State Administration of Traditional Chinese Medicine
Could 2019 be the “year of the reckoning” for off-patent originator drugs?

Multiple implications including:
- Strategy decision for MNC manufacturers – ride the price/volume curve or deprioritize?
- Potentially greater reimbursement resources available to support innovative drugs?

Pain is coming for mature brands
– GM China MNC Pharma
GQCE progress review: mission impossible to complete “289 list” by end of 2018

Significant delay achieving target of “289 list completion”

- **Up to Oct 2018, only 18 on the 289 list have passed QCE, while 68 are in application process**

QCE application and approval by 289 list status

<table>
<thead>
<tr>
<th># of molecules</th>
<th>On &quot;289 list&quot;</th>
<th>Not on &quot;289 list&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approval</td>
<td>18</td>
<td>93</td>
</tr>
<tr>
<td>Application</td>
<td>68</td>
<td>34</td>
</tr>
</tbody>
</table>

Future outlook

- **Oral solid dosage**
  - 2018 year-end deadline for 289-list is likely to be extended “implicitly”
  - In the near term, QCE deadline for additional OSD molecules is unlikely to be announced, given the slow speed of 289 list completion

- **Sterile injectables**
  - Post the “draft for discussion” guidance in 2017, official plan is likely to be announced in 1-2 years

1 Application data as of Sep 26th 2018, approval data as of Oct 8th 2018

SOURCE: Press release, expert interviews, team analysis
2. Gx companies are pursuing molecules with large market size, many beyond the “289 list”

A significant portion of GQCE applications are for molecules with attractive market size

# of molecules under QCE application, sample = top 142 OSD molecules, ranked by RDPAC 2017 revenue

<table>
<thead>
<tr>
<th>Large market size</th>
<th>Small market size</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; USD50 mn</td>
<td>&lt; USD50 mn</td>
</tr>
<tr>
<td>Total # of Molecule¹</td>
<td></td>
</tr>
<tr>
<td>No QCE</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>40%</td>
<td>50%</td>
</tr>
<tr>
<td>GCE application</td>
<td></td>
</tr>
<tr>
<td>52</td>
<td>60</td>
</tr>
<tr>
<td>46%</td>
<td>90%</td>
</tr>
</tbody>
</table>

62% of top 142 Oral Solid Dosage molecules’ will face GQCE competition in the near future

~USD9 bn revenue at stake for MNCs

1 Based on 667 molecules from RDPAC

SOURCE: GBI database, Industry associations, team analysis
Margin and technical barriers are the other two key considerations for pursuing GQCE

- Products with **significant price gap** between MNC originator and local Gx
- Attractive **in-market price** (e.g., some EDL drugs priced very low even before QCE are less likely to be selected)

**First wave** of QCE focused on molecules with medium to low technical barrier to compete for speed to market

**Next wave** of QCE will gradually shift towards molecules with medium to high technical barrier with **product differentiation**
MNC’s traditional top-sales products will face fierce competition post GQCE approval

Overview of Top 20 MNC Oral Solid Drug (OSD) products in China (based on 2017 revenue)

<table>
<thead>
<tr>
<th>Number of drugs</th>
<th>Drugs (molecule name)</th>
<th>Originator revenue (USD bn)</th>
<th>Revenue % in top 20 OSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Atorvastatin, Clopidogrel, Amlodipine, Rosuvastatin, Metformin, Entecavir</td>
<td>4.5</td>
<td>60%</td>
</tr>
<tr>
<td>6</td>
<td>Acarbose, Nifedipine, Metoprolol, Esomeprazole, Tacrolimus, Capecitabine</td>
<td>2.3</td>
<td>31%</td>
</tr>
<tr>
<td>3</td>
<td>Aspirin, Rivaroxaban, Mycophenolate Mofetil</td>
<td>0.7</td>
<td>9%</td>
</tr>
</tbody>
</table>

- 11 out of top 20 OSD products have Gx passed QCE, counting for ~60% of top 20 revenue
- For molecules without QCE approval today, typically there are technical barriers in formulation (e.g., controlled release) or BE requirement (e.g., patient recruitment difficulties)

SOURCE: Industry database, GBI, NMPA, team analysis
As the frontrunner in volume-based group procurement, the Shanghai model is referenced by “4+7” pilots in policy design.

**Background of group purchasing**

- Pilot of 1\textsuperscript{st} batch volume-based purchasing
- Oct 2016 – Announced the results of 2\textsuperscript{nd} batch volume-based purchasing
- June 2018 – Announced the results of 3\textsuperscript{rd} batch volume-based purchasing
- Nov 2018 – Announced pilot of “4+7” policy
  - 4 municipal cities (Beijing, Shanghai, Tianjin & Chongqing)
  - 7 other cities (Shenyang, Guangzhou, Dalian, Xi’an, Shenzhen, Xiamen, Chengdu)

**Results observed from the most recent (3\textsuperscript{rd}) batch of Shanghai volume purchasing**

- Among the 21 categories (molecule * formulation * dosage) whose results have been announced, no originator won the bid
- Except for Sandoz (winner of 2 categories), all the winners are local Gx players
- All categories faced considerable price drop compared with last round of tender, e.g., glimepiride (-79%), lamivudine (77%), rosuvastatin (-22%)
- Only model nationwide that links volume to price - winner of tendering will enjoy at least 50% of total volume
- It is estimated that actual volume share of winner will be even higher (>70%) due to hospital budget pressure

**SOURCE:** press search; team analysis
Leading local companies and other MNCs alike have concerns over centralized “4+7” pilot policy, especially on quality and volume of supply.

Announced purchasing rules in “4+7” cities:

- **Purchasing volume guaranteed** for the drug with lowest bidding price among molecules that passed GQCE. Volume proposed by each city is estimated based on 60-70% of last year’s total volume.

- **Official reimbursement policy to be published**, with the potential to set final bidding price as reimbursement price.

- **31 products** selected for first batch.

Gx substitution with reduced price is the right direction and future trend; however, I am concerned that companies passing QCE may not be able to guarantee **high-quality supply capacity**.

The current model will push MNCs **out of the market**, which will be detrimental for China pharma industry. I personally expect government to make further adjustments along the way.

Impact from current round of “4+7” tendering on individual products subject to local policy rollout and should be closely monitored.

1 Including Beijing, Shanghai, Tianjin, Chongqing, Guangzhou, Shenzhen, Shenyang, Dalian, Xi’an, Chengdu and Xiamen.

SOURCE: Press search, team analysis, expert interview
Given this, we see 3 main strategic options at brand level for MNCs:

1. **Ride the price/volume elasticity curve**
   - Compete on Quality AND Price
   - Ramp up supply chain capacity
   - Expand footprint with omni channel

2. **Retreat on the core**
   - Be more selective on prioritized provinces/cities/hospitals
   - Adjust price but maintain healthy premium
   - Gradually ramp down investments

3. **Deprioritize or partner out**
   - In some cases, exit market given profitability and growth outlook
   - In others, find a local partner to promote
In summary, we are nearing the reckoning point for mature products while speed of access broadening for innovative products still needs to accelerate.

Clear signs of acceleration in broadening of innovative drug access, though not yet at the speed needed.

NRDL listing demonstrates significant impact on improving innovative drug accessibility. Careful assessment of price volume tradeoff needed to ensure future sustainability.

A “second-launch mindset” of optimizing commercial model and enhancing internal coordination is critical to realize full value post NRDL inclusion.

Government push towards resource extraction from mature portfolio through GQCE implementation and new tendering rules will continue.

Significant pressure and convergence towards developed market profile is expected in the next few years.

Accelerated commercial model transformation for mature portfolio expected from industry players in response to market evolution.
4 key questions to explore …

01. Macro market evolution?

02. Momentum of the innovation drive?

03. Speed of improvement in market access?

04. Impact of Digital and Analytics?
Key trends shaping DnA in China healthcare

1. Clear policy tailwinds (e.g., new guideline on “Internet plus healthcare”)
2. Patients and physicians becoming increasingly digital savvy
3. Growing aspiration from technology giants and start-ups alike
4. Waves of strategic partnerships pilots between technology giants/startups and MNC/Local pharmacos

5. Pilots commercial viability not clear, profitable business model yet to be seen
6. Fragmented ecosystem with redundant services across platforms and fragmented infrastructure (e.g. data)
7. Battlefield for scarce talents with experience across healthcare/technology
1. Government has issued a range of policies and implementation guideline to support and regulate digital/analytics disruption in healthcare

### Policies to support digital and AI solutions...

- The CPC passed *Healthy China 2030* plan, with focus on health information system, including **big data application** in healthcare
- State Council published new **guideline on “Internet Plus healthcare”** to
  - Establish comprehensive healthcare system **empowered by internet**
  - Improve IT infrastructure supporting **“internet plus healthcare”**
  - Strengthen **oversight to secure data safety** and service quality

### Detailed guidelines to drive implementation

- AI and digital healthcare product will be **regulated by NMPA**
- NHC detailed the management of **online consultation, internet hospital and telemedicine**
- NHC issued the Administrative Measures on the Standards, Security and Service of Health and Medical Big Data (trial) to **regulate data protection in the healthcare industry**

### Implications

- Clear government support on applications of digital, AI and big data to healthcare
- Online prescription opening for common disease and follow-up visits of chronic disease; online consultation, drug purchase and delivery in a loop now
- Taping into digital solutions becomes a differentiator for biopharmas

**SOURCE:** State Council; NHC; Press search; McKinsey analysis
Major eHealth solutions see significant adoption by patients and physicians

<table>
<thead>
<tr>
<th>Patients and physicians using digital solution in China¹</th>
<th>Comparison with US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physicians active on top 3 online education platform</td>
<td>Patients using largest online consultation platform², mn</td>
</tr>
<tr>
<td>1.5 mn</td>
<td>15.6</td>
</tr>
<tr>
<td>Physicians active on top 3 online consultation platforms</td>
<td></td>
</tr>
<tr>
<td>20 mn</td>
<td>China: active users; US: total visits (# of active users might be smaller)</td>
</tr>
<tr>
<td>Active users and &gt;700 k registered physicians on top 3 online consultation platforms</td>
<td></td>
</tr>
<tr>
<td>3.0 mn</td>
<td></td>
</tr>
<tr>
<td>Patients making appointment on top 3 platforms</td>
<td></td>
</tr>
<tr>
<td>3.0 mn</td>
<td></td>
</tr>
<tr>
<td>Patients making appointment on top 3 platforms</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Patients buying drugs on top 3 B2C platforms</th>
<th>Physicians active online</th>
</tr>
</thead>
<tbody>
<tr>
<td>656 k</td>
<td>~40% physicians have used online consultation</td>
</tr>
<tr>
<td>Patients managing diabetes with top 3 e-solutions</td>
<td></td>
</tr>
</tbody>
</table>

1 All numbers are based on 2017 first half year observation
2 2017 1H; China: active users; US: total visits (# of active users might be smaller)

SOURCE: press search; team analysis
Digital healthcare players are attracting continuous investment with healthy valuations

SELECTED EXAMPLES

**XtalPi**
- Round B, USD15 mn
- Valuation USD5.5 bn

**HY 汇医慧影**
- Round C, USD50 mn
- Valuation USD5.5 bn

**Airdoc**
- Round B, USD50 mn
- Valuation USD5 bn

**LinkDoc**
- Round D, USD145 mn
- Valuation USD5 bn

**Predicine 慧渡医疗**
- Round B, USD15 mn
- Valuation USD1.4 bn

**推想科技 interVISION**
- Round D, USD45 mn
- Valuation USD1.4 bn

1 Tech giants include Tencent, Alihealth, PingAn and their direct investment

SOURCE: press search; team analysis
TAPJ have entered digital healthcare from different angles, and are enriching services across care continuum.

<table>
<thead>
<tr>
<th>Entry points</th>
<th>Offerings over time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triage &amp; registration</td>
<td>Online hospital</td>
</tr>
<tr>
<td>Tencent 腾讯</td>
<td>✓</td>
</tr>
<tr>
<td>阿里巴巴</td>
<td>✓</td>
</tr>
<tr>
<td>中国平安 PINGAN</td>
<td>✓</td>
</tr>
<tr>
<td>京东</td>
<td>✓</td>
</tr>
</tbody>
</table>

SOURCE: Expert interviews; team analysis
Leading Chinese tech giants have all set high aspirations in Healthcare and have started laying out the footprint to expand business overseas.

**In China**

<table>
<thead>
<tr>
<th>Company</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>PingAn</td>
<td>The biggest private health/medical insurance provider</td>
</tr>
<tr>
<td>PingAn Health</td>
<td>The first online health management provider IPO in Hong Kong for USD1 bn at a valuation of USD5 bn</td>
</tr>
<tr>
<td>PingAn Doctor</td>
<td>Leading platform serving the health insurance serving ~800Mn people across over 200 cities</td>
</tr>
<tr>
<td>HK listed</td>
<td>HK listed with mkt cap of USD10 bn+</td>
</tr>
<tr>
<td>The biggest online pharmacy</td>
<td>The biggest online pharmacy</td>
</tr>
<tr>
<td>Future hospital</td>
<td>The first end-to-end mobile service platform for 2600+ hospitals</td>
</tr>
<tr>
<td>Tencent</td>
<td>Valuation at ~USD6 bn, potential IPO in 2019; strategic partnership with AIA</td>
</tr>
<tr>
<td>The first national certified AI medical imaging open platform</td>
<td>The first national certified AI medical imaging open platform</td>
</tr>
<tr>
<td>Jingdong Medicine</td>
<td>The first platform to provide both B2C retail service and B2B purchasing solution</td>
</tr>
<tr>
<td>Jingdong</td>
<td>Online hospital featured in remote medical treatment, online payment and prescription circulation</td>
</tr>
</tbody>
</table>

- Local tech giants have established strong base in data capabilities in China healthcare industry
- Increasing trend of globalization is seen, backed up by over 25 overseas deals made in the past three years by local tech giants under various formats, including joint venture, M&A and strategic partnership

**Beyond China**

<table>
<thead>
<tr>
<th>Company</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grab</td>
<td>First USD bn startup with wide footprint in southeast Asia providing one-stop digital health services</td>
</tr>
<tr>
<td>Prenetics</td>
<td>Leader in digital health in Southeast Asia with USD40 mn fund raised</td>
</tr>
<tr>
<td>CNOGA Medical</td>
<td>AI technology to diagnose Parkinson’s Disease in min</td>
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<tr>
<td></td>
<td>USD50 mn investment for collaboration on cloud health monitoring and diagnosis</td>
</tr>
</tbody>
</table>

SOURCE: Team analysis; press releases
AI applications are also developing fast and covering various topics across TAs

Start-ups in healthcare AI are emerging

<table>
<thead>
<tr>
<th># of Healthcare AI companies successfully raising fund since 2013¹</th>
<th>Examples of AI applications relevant to biopharma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical imaging</td>
<td>Medical machine translation</td>
</tr>
<tr>
<td>35</td>
<td>Intelligent pharmacovigilance</td>
</tr>
<tr>
<td>EMR/literature analytics</td>
<td>Intelligent regulatory affairs</td>
</tr>
<tr>
<td>16</td>
<td>Smart synthetic route design and etc.</td>
</tr>
<tr>
<td>Surgical robotics, smart rehabilitation device</td>
<td></td>
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<tr>
<td>12</td>
<td></td>
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<tr>
<td>Virtual assistance</td>
<td></td>
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<tr>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Wellness management</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Pharma R&amp;D</td>
<td>Protein-ligand orbital docking</td>
</tr>
<tr>
<td>5</td>
<td>Target virtual screening</td>
</tr>
<tr>
<td>AI+genetics</td>
<td>Drug design and lead optimization</td>
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<tr>
<td>4</td>
<td></td>
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<tr>
<td>Disease screening and risk prediction</td>
<td>Crystal structure prediction</td>
</tr>
<tr>
<td>2</td>
<td></td>
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<tr>
<td>Hospital management</td>
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</tr>
</tbody>
</table>

¹ Data till August 2018

SOURCE: Press search, McKinsey analysis
Digital/analytics partnerships between MNC pharmacos and tech giants/startups can be broadly categorized into eight archetypes, each addressing different needs.

**PATIENTS**

- **Drug information and disease education**
  - Mobile app based retrieval of drug information, related disease knowledge and advise
- **Patient education and management**
  - Disease education, physician/patient communication and lifestyle management, especially for chronic disease
- **Online appointment**
  - Convenience of online consultation registration
- **Online consultation**
  - Connect patients with physicians and provide patients with disease treatment solutions

**PHYSICIAN**

- **CDSS and risk prediction**
  - Big data enabled diagnosis assistance with established model for disease and risk prediction
  - Online communication forum
  - Digital platform for physician interactions

**PHARMACO**

- **E commerce and new retail model exploration**
  - Cloud-based direct-to-patient (DTP) pharmacy services to meet patients’ medication needs
- **R&D**
  - Partnerships on drug discovery to speed up locally relevant innovation and reduce cost
- **Commercial excellence**
  - Maximize commercial efficiency through digital/AI enabled SFE, Digital marketing and CRM
Leading MNCs are actively establishing digital/analytics partnerships to address stakeholder needs

<table>
<thead>
<tr>
<th>Pfizer</th>
<th>Alibaba Group</th>
<th>Tencent</th>
<th>JD.com</th>
<th>Ping An</th>
<th>Other tech companies/initiatives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</table>
# Strategic digital partnership pilots by local pharmacos emerging

<table>
<thead>
<tr>
<th>Local pharmaco</th>
<th>Digital players</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SGPH</td>
<td>JD.COM</td>
<td>Partnership on &quot;Cloud health&quot; platform with digitalization of medical record and drug and patient information.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Partnership on both online and offline digital health services including clinics and pharmacy operation.</td>
</tr>
<tr>
<td>CRI</td>
<td>PINGAN</td>
<td>Strategic partnership to develop end-to-end healthcare services including online consultation, prescription and distribution through e-commerce.</td>
</tr>
<tr>
<td>ZNM</td>
<td>PINGAN</td>
<td>Strategic partnership on chronic disease management based on big data and AI technology.</td>
</tr>
<tr>
<td>SMI</td>
<td>Tencent</td>
<td>Digital/analytics partnership on chronic disease management using wearable devices and comprehensive personal health data management services.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wide range of &quot;Pharma+AI&quot; themed collaboration to address needs across stakeholders, e.g.,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Patient management and education</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• AI assisted diagnosis and treatment for physician</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Big data and IoT based intelligent marketing</td>
</tr>
</tbody>
</table>

- Various digital/analytics partnerships start to emerge from local pharmacos to address patients, physicians and pharmaco’s need.
- However, level of activities remains low compared to MNC pharmacos, and mostly scattered in terms of collaboration archetypes.

**SOURCE:** Team analysis; press releases
Consolidation across companies starting to happen with goal of providing better integrated solutions to patients

<table>
<thead>
<tr>
<th>Company</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ali Health</td>
<td><strong>TMall pharmacy</strong> was acquired by Ali Health in 2016; consolidation continued in 2018 with <strong>TMall medical devices and healthcare products</strong> being acquired by Ali Health. Acquisition aims to <strong>consolidate healthcare e-commerce into “one rooftop”</strong> to maximize synergy in operation and patient access.</td>
</tr>
<tr>
<td>Tencent</td>
<td><strong>Tencent Doctorworks</strong> and <strong>Trusted Doctors’ online and offline operations</strong>, including online consultation, information management system and offline clinics, merged in 2018. Merger aims to complement and strengthen service offerings to form an <strong>end-to-end healthcare solution</strong> for users.</td>
</tr>
<tr>
<td>PingAn Good</td>
<td>PingAn GoodDoctor acquired PingAn Wanjia in 2018 to consolidate <strong>online and offline medical resources</strong>. The consolidation is to <strong>leverage each other’s patients pool</strong> and provide <strong>streamlined full healthcare solutions</strong> at scale.</td>
</tr>
<tr>
<td>Tencent</td>
<td><strong>Tencent Doctorworks</strong> and <strong>Trusted Doctors’ online and offline operations</strong>, including online consultation, information management system and offline clinics, merged in 2018. Merger aims to complement and strengthen service offerings to form an <strong>end-to-end healthcare solution</strong> for users.</td>
</tr>
<tr>
<td>Wanjia Healthcare</td>
<td>Connecting Wanjia with GoodDoctor will maximize resource sharing both online to offline, and offline to online.</td>
</tr>
</tbody>
</table>

*Our goal is to establish an end-to-end solution to patients with drug, healthcare and insurance.*

*We hope to connect patients and physicians to synergistically provide high quality service and radiate to broader regions.*

*Connecting Wanjia with GoodDoctor will maximize resource sharing both online to offline, and offline to online.*

SOURCE: Team analysis; press releases
### Key issues with talent supply today

<table>
<thead>
<tr>
<th>Limited overall talent supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Urgent need to build other related capabilities such as designer, data architect</td>
</tr>
<tr>
<td>- Shortage of talents with deep understanding of both healthcare and DnA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lack of value proposition to attack and retain talents</th>
</tr>
</thead>
<tbody>
<tr>
<td>- DnA talents are struggling to find out their value and career paths in pharmacos</td>
</tr>
<tr>
<td>- Overall environment is not empowering due to industry conservatism (e.g., stringent compliance measures)</td>
</tr>
</tbody>
</table>

### Potential solutions at industry level

<table>
<thead>
<tr>
<th>Bring talents from other industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Commit to bring in real development in digital/analytics, and proactively seek for talents from other industry</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Create an enabling environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Find the root cause of constrains on digital/analytics adoption in biopharma industry</td>
</tr>
<tr>
<td>- Proactively look for breakthroughs in controllable areas such as regulatory, compliance</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Build talent pool from within</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Identify high potential young talents with strong digital/analytics savviness within healthcare industry</td>
</tr>
<tr>
<td>- Creating training and accreditation programs to develop “digital/analytics+” healthcare talents</td>
</tr>
</tbody>
</table>
Strategic imperatives for Biopharma industry in the age of DnA

<table>
<thead>
<tr>
<th>1</th>
<th>Shift mindset</th>
<th>Digital/analytics shifts from “nice to have” to “must have”</th>
<th>Proactively seeking new commercial model adoption through both internal creation and external partnership</th>
<th>Create ecosystem play, considering long term partnership with digital giants to stay relevant with the latest innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Choose strategically</td>
<td>Formulate strategy with long term aspiration instead of changing tactics constantly</td>
<td>Deploy quick pilots for “proof of concept” ideas, fast iterate based on feedback and fast replication with successful pilots</td>
<td>Develop signature digital programs to differentiate value propositions and avoid becoming a pilot junkyard</td>
</tr>
<tr>
<td>3</td>
<td>Bring changes to life</td>
<td>Develop critical internal talent, infrastructure and capabilities</td>
<td>Instead of using shared resource, dedicated resource should be ringfenced (e.g., innovation hub) to support the transformation</td>
<td>Build appropriate approaches to evaluate the ROI of new business models</td>
</tr>
</tbody>
</table>
Future of digital and analytics in healthcare – 5 predictions for 2025

- Online hospital and online Rx prescription: new norm for patients
- Emergence of 10+ smart cities nationally with data connectivity established across healthcare systems and digital capabilities
- Leading digital healthcare companies bring digital solution innovation developed in China to the globe
- Wide adoption of AI enabled clinical decision support systems, especially in lower tier hospitals and cities
- Biopharma Chief Digital/Analytics Officer becomes a must-have role for all biopharma companies
Digitalization emerging as an essential pillar for customer engagement
However it has yet to fundamentally transform the industry and much more work is needed to get there

Fast emerging China innovation ecosystem
With a wave of promising companies fueled by access to talents and access to capital, but still early in their development

Clear signs of acceleration in broadening of innovative drug access; much more is needed
A “second-launch mindset” for optimizing commercial model is critical for companies to capture full value post reimbursement inclusion

2019 could be the “year of reckoning” for mature brands
Significant impact expected from implementation of GQCE coupled with new tendering rules

We are on a narrow, but clearly broadening bridge
Uptake of innovation starting to accelerate, while mature products will come under much stronger pressure in the coming few years

Closing thoughts
Our China healthcare leadership team (13 Partners and Associate Partners)

For more on China healthcare…

www.mckinseychina.com

Industry insights

Collaboration with CPA

2018 New product launch roundtable

2018 China Biotech roundtable

Collaboration with CEIBS & Korn Ferry on Healthcare CEO Salons

2018 PE roundtable