



# **Pharmaceutical waste stream measurements as an avenue to sustainable pharmacy**

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# Sustainable pharmacy

$$\text{Rational drug use grade} \approx \frac{\text{Healthcare footprint}}{\text{Ecological footprint}}$$

$$\text{Rational drug use grade} \approx \frac{1}{\text{Waste level}}$$

# References

Castensson S, Ekedahl A. Pharmaceutical Waste: The Patient Role. In: Kümmerer K, Hempel M, eds. Green and Sustainable Pharmacy. Berlin, Heidelberg, New York: Springer (forthcoming)

Fant H, Bennet R, Ekedahl A, Castensson S. Antibiotic waste levels at an infectious disease ward for children. Poster at the CleanMed Europe Congress; 2006 May 29-31, Stockholm, Sweden

# Pharmaceutical Waste: The Patient Role

Studies are summarized in seven tables in the following order

- ▶ Amounts returned to pharmacies
- ▶ Packages returned to pharmacies past their expiry date
- ▶ Storage time of drugs before bringing back to the pharmacy
- ▶ Distribution of drugs returned to pharmacies
- ▶ Proportion of retired patients and proportion of packages returned by these patients
- ▶ Reasons
  - Primary factors related to the pharmacotherapy
  - Secondary factors related to the pharmacotherapy and unrelated

<b>Country</b>	<b>Sample size, pharmacies</b>	<b>Sample size, packages</b>	<b>Proportion of drugs sold [%]</b>
<b>Germany</b>			
Zimmer et al. (1999)	15	4351	~5
Heeke and Günther (1993)	195	6897	5.3
Zimmer et al. (1992)	20	5760	~5
<b>France</b>			
Marchiset-Ferlay et al. (2001)		10254	3.6 (value)
<b>UK</b>			
Linton (2003)	18	1819 <sup>a</sup>	0.65 (value)
Cromarty (1998)	60	2042	0.7 (value)
<b>Sweden</b>			
Ekedahl et al. (2003)	100	20171	3.8 <sup>b</sup> ( <i>DDD</i> )
			2.2 (value)
Agness (2002)	40		5 (value)
Jonsson (2000)	31	1554	2.4 (value)
Isacson and Olofsson (1999)	65	8014	2.4 ( <i>DDD</i> )
<b>Switzerland</b>			
Gehler et al. (1998)	66	10011	5.5 (packages)
<b>Denmark</b>			
Lægemedelstyrelsen (2003)	28	9077	1.45 (value)
<b>Norway</b>			
ECON (2002)	25	2687	~2

*DDD* = Defined Daily Doses. <sup>a</sup>Drugs instead of packages. <sup>b</sup>Includes drugs without package.

# Packages returned to pharmacies

Sweden 10 years ago

- ▶ 65 % with  $> 2/3$  of the content left
- ▶ 38 % were intact
- ▶ 51 % were expired



<b>Country</b>	<b>Sample size, packages</b>	<b>Returned past expiry date [%]</b>
<b>Germany</b>		
Zimmer et al. (1999)	4351	71
<b>UK</b>		
Linton (2003)	1819 <sup>a</sup>	8
Collins (2001)	309	17
Braybrook et al. (1999)	1428	3
Cromarty (1998)	2005	3
Hawksworth et al. (1996)	1091	5
<b>Canada</b>		
Carter and Coppens (1996)	2348	25
<b>Sweden</b>		
Ekedahl (2006)	9077	61
Ekedahl et al. (2003)	11093	51
Jonsson (2000)	1554	45
Isacson and Olofsson (1999)	7783	48
Bäckström and Olme(1997)	1159 <sup>a</sup>	38
<b>Switzerland</b>		
Gehler et al. (1998)	~4700 <sup>b</sup>	50
Gehler et al. (1998)	~4200 <sup>c</sup>	71
<b>Norway</b>		
Thormodsen et al. (1997b)	3493	14

<sup>a</sup>Drugs instead of packages. <sup>b</sup>Calculated R<sub>x</sub> sample. <sup>c</sup>Calculated OTC sample

<b>Country</b>	Sample size, packages	<1 month [%]	<½ year [%]	<1 year [%]	<2 years [%]	<3 years [%]	<4 years [%]	<5 years [%]	<10 years [%]	>5 or >7 years [%]
<b>USA</b>										
Garey (2004)	1315					63			94	6 (>7)
<b>UK</b>										
Mackridge and Marriott (2007)	3765			71						
Linton (2003)	1819 <sup>a</sup>		57	69	78			85		2 (>5)
Grant (2001)	3099		47	63						
Braybrook et al. (1999)	1428			80	89	93	95			
Cromarty (1998)	2005	25		74	94					
Hepburn et al. (1997)	1705	30								
Cook H (1996)	631		63 <sup>b</sup>	77						
<b>Canada</b>										
Grainger-Rousseau et al. (1999)	1966							87		
Carter and Coppens (1996)	2348			53				91		9 (>5)
<b>Australia</b>										
Longmore et al. (1995)	6556		23	38	56	71	80	86		14 (>5)
<b>Sweden</b>										
Ekedahl (2006)	9077		16	27	43			74		26 (>5) 8 (>7)
Ekedahl et al. (2003)	11093		22	35	51	64		80		
Jonsson (2000)	1554			33	45	54	64	70		
Isacson and Olofsson (1999)	5973	8 <sup>c</sup>		38 <sup>c</sup>	55 <sup>c</sup>	67 <sup>c</sup>		84 <sup>c</sup>	98 <sup>c</sup>	14 (>5)
<b>Denmark</b>										
Lægemedelstyrelsen/Danmarks Apotekerforening (2001)			37 <sup>d</sup>		64 <sup>e</sup>					

<sup>a</sup> Drugs instead of packages. <sup>b</sup>49% < 3 months. <sup>c</sup>Plus 2 months. <sup>d</sup> < 4 months. <sup>e</sup> < 16 months.



# Basic reasons for accumulation and disposal

- ▶ Diagnosis and prescription may fail or is not adequate
- ▶ Excess/double prescribing
- ▶ Greater purchase than need
- ▶ Hoarding
- ▶ Design of drug benefit schemes
- ▶ Deceased patient
- ▶ Polypharmacy

<b>Country</b> Reference	<b>Sample size,</b> <b>patients</b>	<b>Sample size,</b> <b>packages</b>	<b>Range</b>	<b>Median</b>	<b>Mean<sup>a</sup></b>
<b>UK</b>					
Linton (2003)	897	1819 <sup>a</sup>	1-34	1	2
McGovern et al. (2002)	100	256	1-17	2	3
Braybrook et al. (1999)	529	1428	1-31		3
Cook H (1996)	133	631	1-72	3	5
Hawksworth et al. (1996)	366	1091	1-27		3
<b>Spain</b>					
Coma et al. (2008)	227	1176	1-121		5
<b>Canada</b>					
Carter and Coppens (1996)	731	2348			3
<b>Sweden</b>					
Ekedahl (2006)	1577	8795	1-140	3	6
Ekedahl (2003)	191	1077	1-101	3	6
Bäckström and Olme (1997)	196	1159 <sup>a</sup>	3 <sup>b</sup> -30		6
<b>Norway</b>					
Thormodsen et al. (1997a)	641	4860	1-70		8
Wold and Hunskår (1992)	247	2750	1-44		11

<sup>a</sup>Drugs instead of packages. <sup>b</sup>Only drug returns  $\geq 3$  were included

Country Reference	Sample size, patients	Sample size, packages	Patients [%]	Packages [%]
<b>UK</b>				
Langley et al. (2005)	114	340		61 <sup>60+</sup>
Linton (2003)	897	1819 <sup>a</sup>	65 <sup>60+</sup>	
Braybrook et al. (1999)	529	1428		67 <sup>60+</sup>
Hawksworth et al. (1996)	360		61 <sup>60+</sup>	
		1091		68 <sup>60+</sup>
<b>Canada</b>				
Grainger-Rousseau et al. (1999)	581	1966		63 <sup>65+</sup>
Carter and Coppens (1996)	731	2348	42/44 <sup>65+</sup>	
<b>Sweden</b>				
Ekedahl (2006)	1577	9077		66 <sup>65+</sup>
Ekedahl (2003)	191		49 <sup>65+</sup>	
		1077		64 <sup>65+</sup>
Ekedahl et al. (2003)		20171		66 <sup>65+</sup>
Jonsson (2000)	299	1554		59 <sup>60+</sup>
Isacson and Olofsson (1999)		8014		63 <sup>65+</sup>
Bäckström and Olme (1997)	196		49 <sup>65+</sup>	
		1159 <sup>a</sup>		47 <sup>65+</sup>

<sup>a</sup>Drugs instead of packages

# Understanding why leftover drugs accumulate



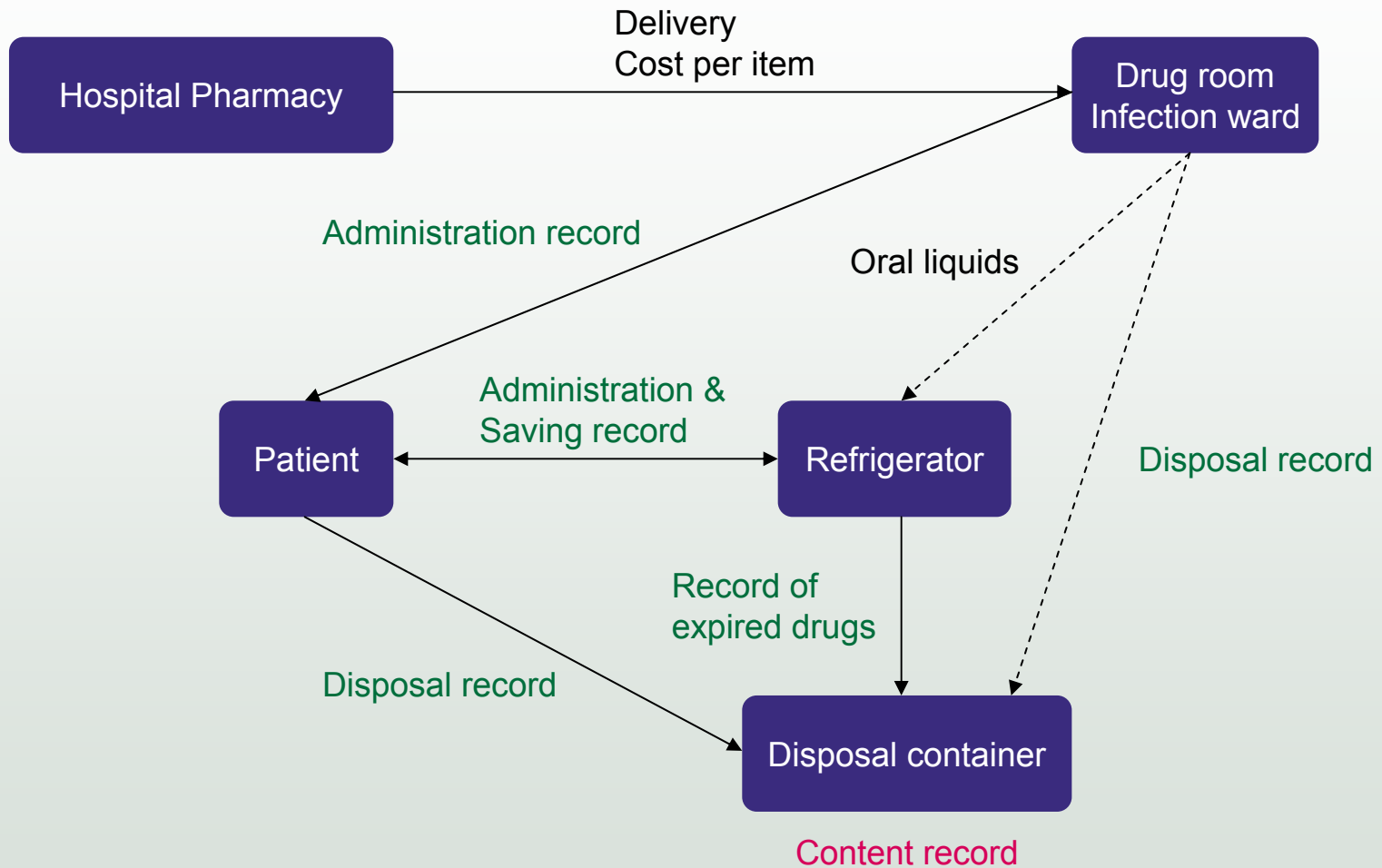
Country	Sample size, patients/packages	Therapy change	Adverse reactions	No effect	Non- adherence	Recovery
<b>UK</b>						
Mackridge and Marriott (2007)	910/4934	17			7	
Mackridge and Marriott (2006)	162/	60	21			54
Langley et al. (2005)	114/340	55				
Linton (2003)	897/1819 <sup>a</sup>	33	4	3	5	2
McGovern et al. (2002)	100/256	48	5		7	
Collins (2001)	102/309	33		7	13	6
Braybrook et al. (1999)	529/1428	44	7		12	
Cromarty (1998)	/2005	20	4			10
Hepburn et al. (1997)	/1705					30
Cook H (1996)	123/631	24			1	
Hawksworth et al. (1996)	360/1091	25				
Credé B (1995)	/1825	30	10			
<b>Spain</b>						
Coma et al. (2008)	227/1176	18	3	3	1	25
<b>Canada</b>						
Carter and Coppens (1996)	731/2348	20	8		7	11
<b>Holland</b>						
Blom et al. (1996)	477/	25	7	5		
<b>Sweden</b>						
Ekedahl (2006)	1022/9077	20	9	6	2	18
Jonsson (2000)	299/1554	33	11			
Bäckström and Olme (1997)	135/1159	38	13	7	5	18
<b>Kuwait</b>						
Abahussain et al. (2006)	264/	49			26	
<b>Norway</b>						
Thormodsen et al. (1997b)	353/3493	23		4		4
<b>New Zealand</b>						
Braund et al. (2008)	126/	37	14	12		

<sup>a</sup>Drugs instead of packages

Country	Sample size, patients/packages	Expired	Stock- piling	Prescri- bing error	Deceased	Other factors
<b>UK</b>						
Mackridge and Marriott (2007)	910/4934	28	1		34	
Linton (2003)	897/1819 <sup>a</sup>	8	1		30	
McGovern et al. (2002)	100/256	1		2	34	
Collins (2001)	102/309	17	8	2	40	9
Braybrook et al. (1999)	529/1428	3	30 <sup>b</sup>	4	14	
			18 <sup>c</sup>			
Cromarty (1998)	/2005	3		1	33	
Hepburn et al. (1997)	/1705				26	
Cook H (1996)	123/631	20	2		53	
Hawksworth et al. (1996)	360/1091	5	23		42	5
Credé B (1995)	/1825		10		57	
<b>Spain</b>						
Coma et al. (2008)	227/1176	28			21	3
<b>Canada</b>						
Carter and Coppens (1996)	731/2348	25			27	
<b>Sweden</b>						
Ekedahl (2006)	1022/9077	22	1		30	
Jonsson (2000)	299/1554	33	5		14	13
Bäckström and Olme (1997)	135/1159	19			48	
<b>Kuwait</b>						
Abahussain et al. (2006)	264/	11	10 <sup>b</sup>			
			30 <sup>c</sup>			
<b>Norway</b>						
Thormodsen et al. (1997b) <sup>d</sup>	353/3493	14			50	6
<b>New Zealand</b>						
Braund et al. (2008)	126/	28				

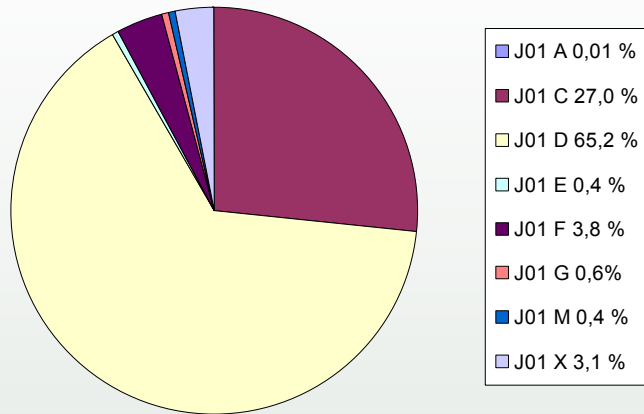
<sup>a</sup>Drugs instead of packages. <sup>b</sup>Excess/double prescribing. <sup>c</sup>Greater purchase than need. <sup>d</sup>Hospitalization 4%.

# Flow of antibiotics and data recording

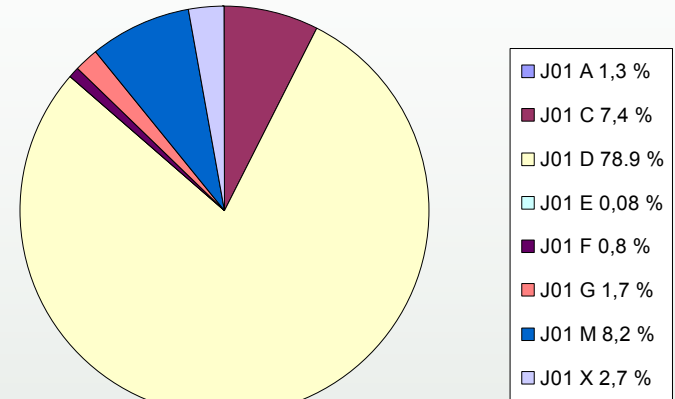


# Total usage and waste of antibiotics

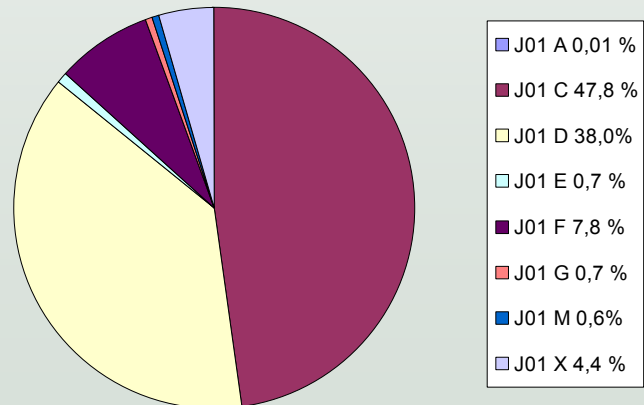
Used amounts according to the ATC-system



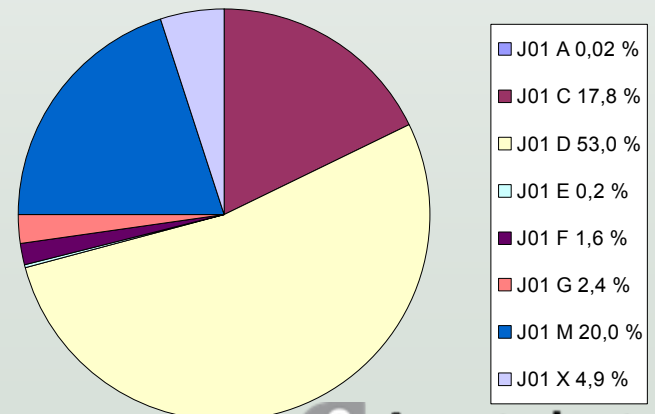
Costs of used amounts according to the ATC-system



Relative amounts of waste according to the ATC-system



Relative cost of waste according to the ATC-system





# Conclusion

## Accumulation and disposal of drugs represent

- ▶ A large, diverse array of data that can be mined to design measures to reduce drug wastage
- ▶ A potential to reduce drug consumption by those for whom the medication was never intended (reduced accidental poisoning and improper or abusive usage)
- ▶ An indicator of potential chemical stressors in the environment when not disposed of in a proper way
- ▶ Wasted healthcare resources and lost opportunities for medical treatment



Thank you for your time and attention. I welcome your questions and comments.

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